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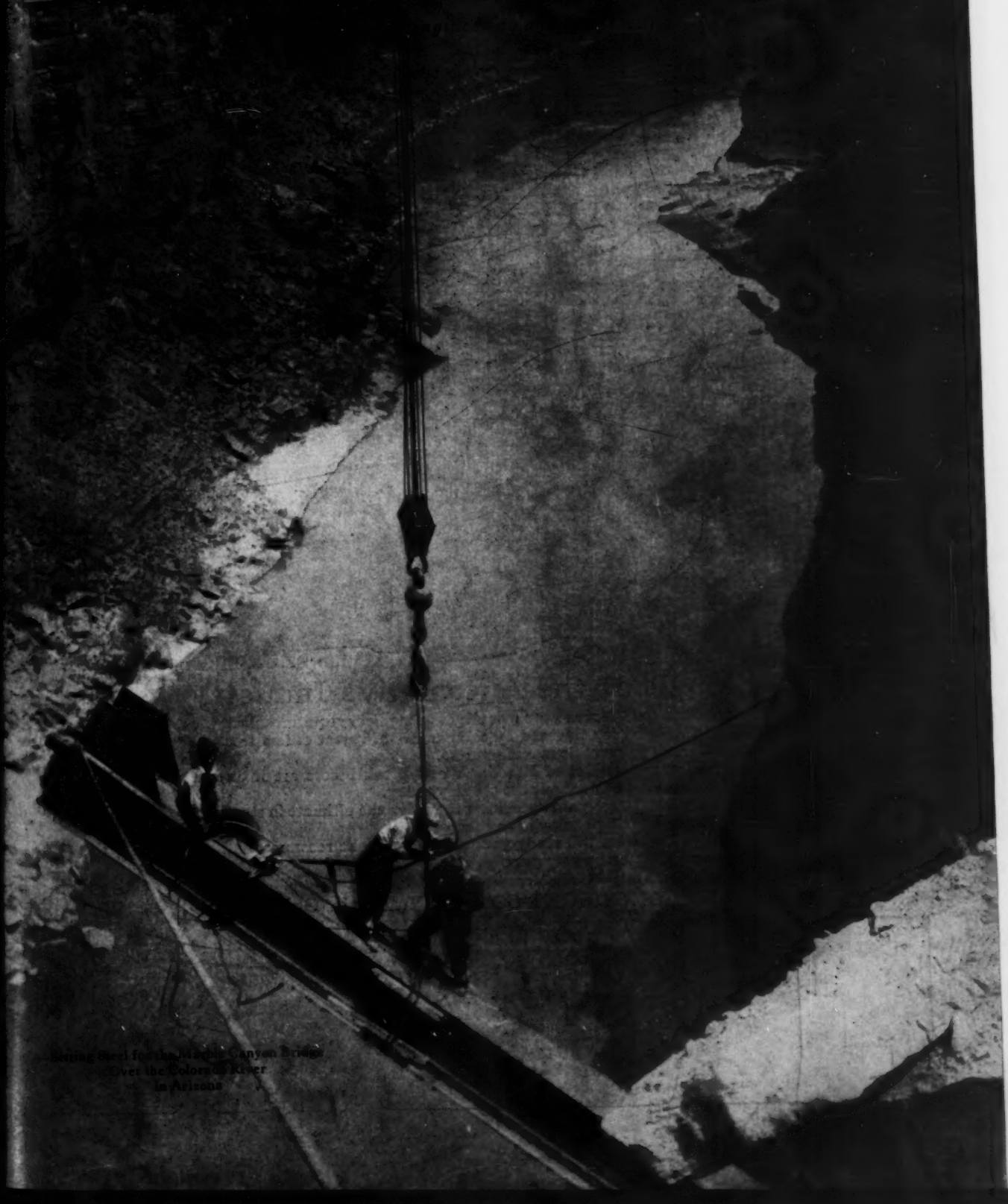

Setting Steel for the Marble Canyon Bridge Over the Colorado River in Arizona

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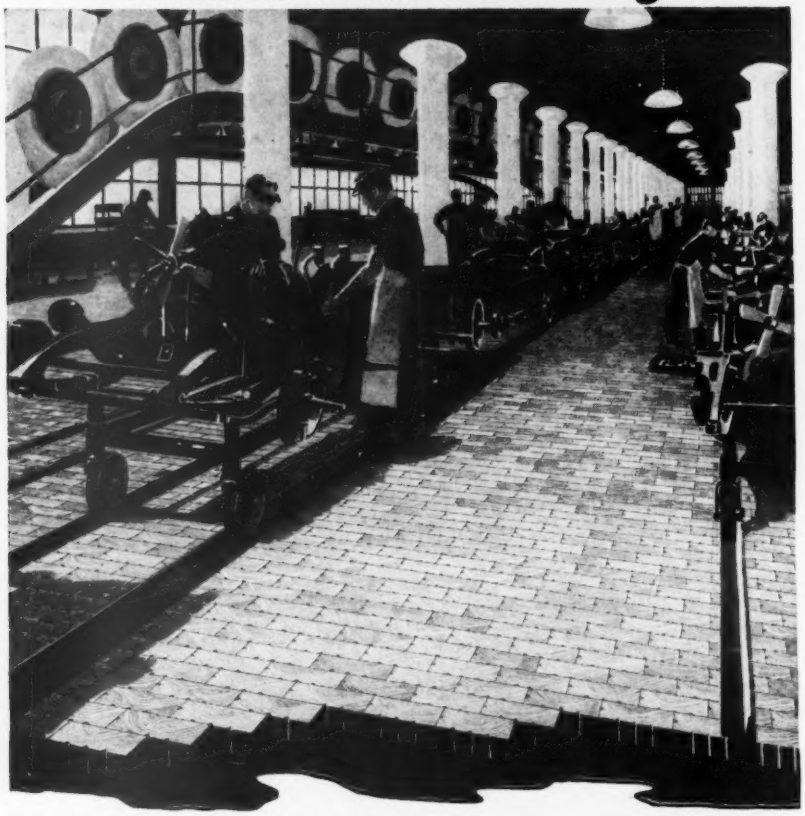

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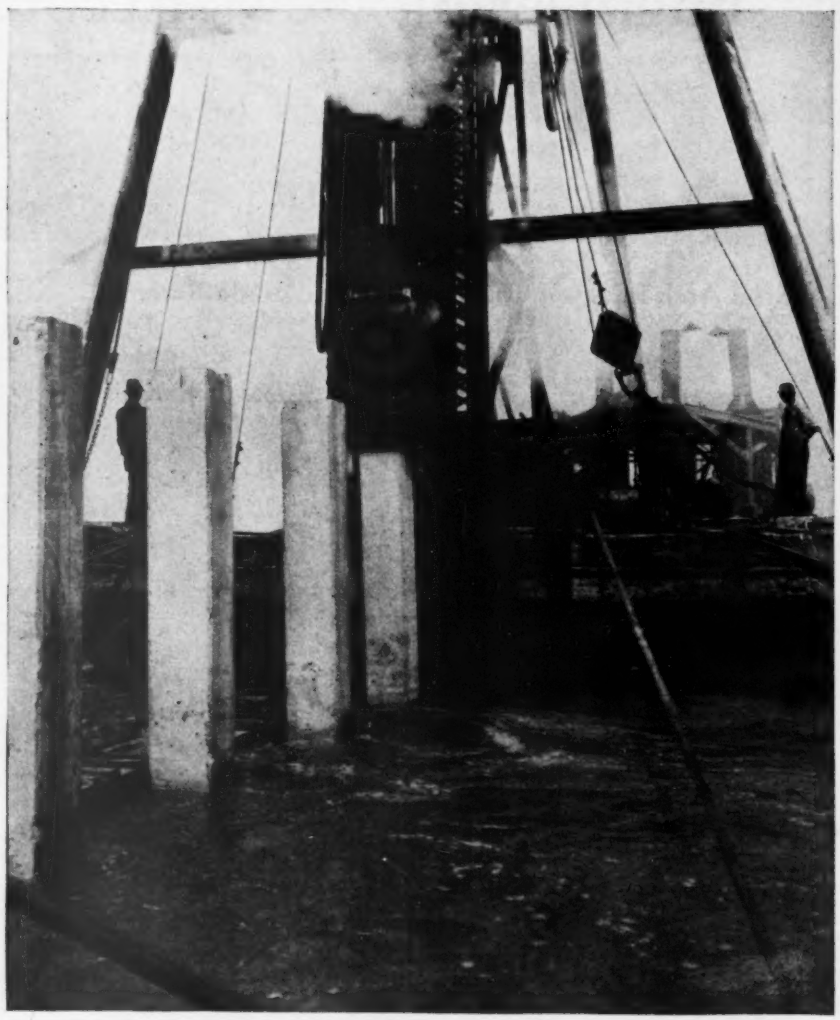

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Volume 101 NEW YORK, NOVEMBER 1, 1928 Number 18

Light for Safety

CINCINNATI is soon to put into effect a new schedule for turning its street lights on and off, a schedule which attempts to provide an adequate amount of light in the streets at all times and in addition is expected to cut down the needless burning of street lights due to inefficient timing. Adequate light rather than economy in current consumption is the fundamental requirement upon which the plan is based (see page 662), but in the long run this program is expected to give the greatest real economy because there is more to be gained by eliminating accidents which result from poor street lighting than can possibly be saved by cutting off the lighting current a few minutes earlier in the morning or turning it on a little later at night. In these days of relatively low electric power rates and high cost of lighting equipment and maintenance, the cost of a few minutes additional artificial light is a negligible portion of the total cost per day. It is through such studies as this one in which all the facts are brought out in their true perspective that we may expect the greatest advances in municipal engineering.

Poor Strategy

REGARDLESS of how right it may be from a legal point of view, the Electric Bond & Share Company showed a lack of appreciation of human psychology in refusing to answer certain questions put to it by the Federal Trade Commission in its investigation of the efforts of the public utility companies to stimulate interest in the continuation of private ownership of public utilities. Its action reminds one of the case of the woman who told the customs inspector not to muss up her neatly arranged trunk and for her pains had everything turned out. The Federal Trade Commission may not have the authority to delve into the affairs of the great holding companies in the public utility field, but Congress has such authority, and nothing could be better calculated to stimulate it into exercising that authority than to have one of these companies act as if it had something to conceal. Developments to date have not revealed anything very damaging to the utility companies, other than proof that the activities of the utility companies in building up public opinion in favor of privately owned public utilities has been widespread. As a result, interest in the investigation has lagged. Now it will be revived, and possibly harmless activities may be colored black by the knowledge that the Electric Bond & Share Company attempted to keep them from the public view.

Earth's Hidden Structure

WITHIN the past 30 or 40 years much progress has been made in general understanding of the close relation between civil engineering work and geological knowledge of earth structure. There is room for further progress. Even today there is great value in a clear statement of how geological study can assist the engineer's work, such a statement as that of Professor Ransome, in this issue. There are many opportunities for utilizing the geologist's knowledge more extensively. To name only two classes of engineering work, both dam and tunnel construction ought in every instance to take advantage of the best geological forecast obtainable, and in general a closer co-operation of these fields of knowledge is to be wished for. But it is important that the engineer understand that when he seeks the geologist's advice he cannot look for precise prediction. Even though the geologist may speak in positive terms, he labors under the same difficulty as the engineer: his knowledge is restricted to the surface. To be sure, his eye is keener than that of the engineer in certain ways, and for this reason his aid is invaluable; but it is a human eye, after all, and what it sees and foresees is subject to error. Therefore the engineer who calls upon the geologist to help him determine the basic conditions of his work must be prudently conscious of his adviser's limitations.

Material and Engineering

OF THE various ways in which the pavement studies reviewed by W. H. Connell this week bear on present-day roadbuilding problems, one is particularly pertinent in this stage of the art. Road types, having generally been given names not according to their basic structural design but according to their surface material, are thought of in terms of that material, and their performance is apt to be considered a characteristic of the material, although it is actually the performance of the whole road structure. More particularly is this true of features of unsatisfactory performance. Ample evidence of this is furnished by all of the predominant modern types of paved road—asphaltic, portland-cement concrete, and brick. Service failures that are chargeable to the roadbed structure as a whole, either to the foundation or to some other element of the design, are set down as failures of the top-course material. Properly we should blame these failures on the engineer of the road rather than on the material. We have, it is true, progressed far in the design and construction of pavements, but there is still a long way to go before the art has reached a satisfactory degree of engineering thoroughness, one which would make it comparable with other civil engineering arts. Fortunately, the trend of the present is in the direction of study of road structure considered in its entirety, a view that is thoroughly sound and should place road construction on a definitely higher plane. It is quite essential to this advance that attention be turned away from supposed virtues or shortcomings of a material, and be focused on how the material is used.

A Broader View

IN THE THEME of the foregoing is contained the essence of the modern roadbuilding art—namely, that its future progress is largely dependent on the breadth of view brought to bear on its major problems. Regard-

ing the roadway as a structural entity and not as a specific material is merely one example of this broader view. It is susceptible as well to application to other phases of highway engineering and in fact to the whole basic road-building program. For instance, during the past decade the goal of the roadbuilder has been mileage. But a broader view of the purpose of the highway will show that it is not enough to cover the nation with first-class roads. These hard-surfaced ribbons must be operated efficiently. The successful manufacturer does not consider his job complete when his plants are running efficiently and his output is adequate. He supplements his production work with merchandising and servicing facilities. So the highway engineer with many miles of highway in operation and additional miles being laid every year should not forget his operation problems. Some of the more obvious of these include the marking of traffic lanes, elimination of bottle-necks and grade crossings, provision of signals, signs and other auxiliaries that speed up traffic and construction of turn-out points for tire changing and other small repair work. By and large, he should build for the future rather than entirely for immediate needs. Fortunately the highway engineer has at his disposal an organization that can effectively encourage this important change in roadbuilding philosophy. The American Road Builders' Association, meeting this coming year in Cleveland, January 14 to 18, brings together the leading highway thinking of the nation. We can only hope that the men who assemble at Cleveland will analyze their meetings, the attendant exhibition of roadbuilding equipment and the future course of the highway industry in the light of this broader view. Only in this way can they adequately satisfy the nation's highway needs.

Bridging the Colorado

BRIDGING the Colorado River is an achievement. This river has but few railroad or highway bridges even in the open stretches at the lower end of the canyon, and until the past month has never had a rail or vehicular crossing on a 600-mile length of the deep, wild gorges through which the river majestically winds its way across Utah and Arizona. The Lee Ferry bridge at Marble Canyon, described in this issue, is about 100 miles up the river from El Tovar, on the rim of the Grand Canyon, and is 130 miles north of Flagstaff, Ariz., the rail point from which trucking had to be done. The isolation of the bridge site may be realized from the fact that an editor of this journal in going from Flagstaff to the bridge traveled more than 70 miles without seeing an automobile or passing a single human habitation. Perhaps the most notable feature of the bridge, in a structural sense, is the ingenious way in which steel members needed for construction were later used as essential parts of the finished structure. So effectively was the design laid out to accomplish this end that, of the freight hauled to the erection crew, 80 per cent was the steel actually left in the bridge. This twofold function of the steel members was developed as a feature in the choice of the type of bridge that could be built with a minimum tonnage of materials to be hauled over 130 miles of desert road. Another construction problem arose from the sudden changes and wide range in temperature to which this location is subject, which made it necessary to have mechanical means of quickly producing a 2-in. change in length of the span at final closure. The construction of this bridge comes near to an idealistic picture of the civil engineer's life work; it has successfully met the challenge of an unconquered river, demonstrated a high degree of physical courage and technical skill, and was carried out in a setting of awe-inspiring scenery that has brought world renown to the canyon of the Colorado River.

Progress and Promise

SELDOM is a convention program as good in design and execution as that of the American Society for Municipal Improvements at Detroit last week. The papers were on live topics, were of high average quality and were admirably grouped to stimulate interest in each session. Those inclined and able to stay through the entire convention were given a review of the problems now uppermost in nearly the whole field of municipal engineering. Those whose time or interest was limited could readily act accordingly.

To round out the high quality of the proceedings, the sessions began at the scheduled time and were so conducted throughout by a competent chairman as rarely to exhibit that breathless rush so deadly to adequate discussion of all the papers when a program is overloaded and the sessions begin a half hour to an hour late.

Manufacturers and other associate members had sufficient representation on the program not merely to satisfy their reasonable demands but also to give the active members a chance to get the supply man's viewpoint. By placing these papers at the close of each session those inclined to show too many lantern slides or moving pictures had their proclivities restrained and in any case did not crowd off papers by active members.

We take all the more pleasure in enumerating some of the good features of the Detroit convention because so many times in the past we have been compelled to point out the shortcomings of the A.S.M.I. meetings. In view of the high character of this year's proceedings, the society should begin immediately to regain its recent losses in membership and soon go far beyond its highest total. As matters stand today, it is the only organization that covers practically the whole field of municipal public works and at the same time is restricted to that field and the closely related field of highway construction outside of cities. Other technical societies are either devoted to a single branch of municipal engineering or else are so far-ranging and have so many technical sections as to be, for practical convention purposes, so many societies holding their meetings at the same time.

Happily and unhappily the percentage of engineers in the association's membership has increased in the third of a century of its life from perhaps 10 to 75 or 80 per cent; happily, because this reflects a large gain in the practice of going to the engineering profession for city engineers, commissioners of public works, street, sewer, water and other department heads; unhappily, because, of the many non-engineer city officials in charge of municipal work, only a small percentage are getting for their cities and themselves the benefits to be derived from membership in the society.

With the promises held out by the Detroit meeting and the many opportunities within its grasp, the American Society for Municipal Improvements may be expected to forge ahead in the next few years. This it cannot do solely on the strength of a notably successful meeting at Detroit or of the indisputably good accomplishments in many lines of effort at previous conventions. Continued hard work is imperative.

The Case of the Foreign Contractor

FEW subjects arouse sharper discussion at meetings of contractors than does foreign-contractor competition. The debate often approaches bitterness. Why? Is foreign-contractor competition a vital problem in the contracting business, and, if so, in what way is it vital? The answer is not simple and little more can be undertaken at this time than to state the question clearly so that the premises for a reasoned discussion are established.

"Foreign" contractors are contractors from outside the community in which the work is being performed. As so defined, foreign-contractor competition ranges all the way from the village sidewalk builder who goes into the next village to lay walks through the increasingly larger operators who go from county to county or from one state to another, up to the great construction organization which carries on a nation-wide business.

How general is foreign-contractor competition? To arrive at an answer a count has been made of the contracts reported by *Engineering News-Record* in 1927, totaling $3,253,793,000. The count shows that in 1927 contractors took 1,504 contracts outside their own states, of average value $306,000 each and in total amount $458,673,000—this in interstate competition alone. It is evident that here is a phenomenon worth consideration.

It would seem that street and road work should be as local as any; yet in 1927 we find 629 contracts, amounting to $85,511,000, or 16 per cent of the $525,096,000 street and road total, going to outside contractors.

In other than road construction, with a contract total of $2,728,697,000, nearly 14 per cent of the total, or $373,162,000, was awarded to 865 foreign contractors. These latter took 39 per cent of the bridge contracts, 34 per cent of the federal government work, 30 per cent of industrial buildings and 18 per cent each of sewerage and water-works jobs. Somewhat surprisingly—because it is in this class of that that foreign-contractor competition has been most bitterly denounced—only 6 per cent of commercial building work (out of a total of $1,632,338,000) went to outside bidders.

Clearly, the foreign contractor is not a negligible factor in the contracting business. He operates extensively enough to be a positively disruptive influence if he does not carry on his business in an ethical manner. There are frequent charges that he does not; but before appraising this accusation let us have some better knowledge of who the foreign contractor is. As it is the roadbuilders who most commonly asperse his origin and conduct, this consideration will be confined to highway work.

A count made in 21 states, all active in highway building, showed 368 foreign contracts. In detail it exhibited the following facts: (1) These foreign contractors came from 30 states, (2) the majority of foreign contractors in any state came from the immediately contiguous states, (3) "immigration" was greatest in the states having a full program of road work and "emigration" was greatest in the states where roadbuilding was slack, and (4) in contiguous states having about equal programs the exchange of contractors was about equal.

In brief, there is no such thing as foreign contractors as a class. For example the fifteen Kansas contractors who worked in Missouri in 1927 were about the same sort of contractors as were the twelve Missouri contractors who simultaneously were doing work in Kansas. Neither of these groups emigrated to escape the police or to find a new field for a get-rich-quick swindle; they went beyond their own states merely to get lucrative work and to do it reasonably well according to their lights.

In thinking of the problem, then, it is necessary to dismiss the notion that the foreign contractor represents a special, vicious type of contractor. The foreign contractor is only a native contractor away from home.

What are the charges against foreign contractors? One is that, without paying their share in money or effort, they encroach upon a territory where a profitable construction business exists due to money and effort expended by native contractors; another is that they bid low through ignorance of local costs or because they are free from or evade the burden of community charges on the native contractor; a third, that they have no future in the community to conserve and so do not hesitate to disrupt local wage and price scales if it is to their immediate advantage. There are other accusations, most of them less creditable to the foreign contractor, but these are sufficient to indicate that the problem of foreign-contractor competition is in essence the maladjustment of the visiting contractor's business conduct with the local contracting practices.

What is the solution? It would be gratifying to announce a simple formula. But the factors of the problem originate in a multitude of influences which today are keeping the contracting business unstable, and therefore no simple formula can apply. One positive statement can be made, however—namely, that the trouble will tend to disappear with growing knowledge and belief of contractors in co-operation, the correction of false credit practices, increased knowledge of costs and co-operation by engineers and architects in demanding prequalification of bidders for construction work. In general there is encouraging advance in all these matters.

What Grade of Concrete?

THREE or four decades of study have been given to that protean material of modern days, concrete. It is doubtful if any other material has ever received as much patient investigation. Yet the truth is that we do not know all that should be known about concrete. Do we, then, know enough about any one kind of concrete to warrant us in attempting to make different grades for different specific uses? Among engineers and constructors it is widely realized that one of today's major technical problems is to learn the art of making *good* concrete —and this word "good" is most broadly inclusive. Yet very frequently the attempt is made to build works of different qualities of concrete in different parts, good concrete here, better concrete there, inferior concrete in a third place. Does experience with the service of concrete reveal any justification for reposing such confidence in our constructional skill?

We believe that this is a very direct challenge question to the present-day civil engineer. He has nearly a half century of concrete production and use to look back upon; has it taught him how to make different grades or qualities of concrete, each adequate to a particular severity of service? Has it shown him where and when he may safely use concrete other than the best? In short, has it given any basis for the belief that there is more than one kind of concrete—namely, the best concrete that skill can produce?

Whatever answer experience can offer to these questions will surely work for progress in one of the most difficult technical problems of the times.

Marble Canyon Arch Bridge Near Lee's Ferry, Arizona

Steel Arch Highway Bridge Across Colorado River

Truck Haul of 130 Miles Affects Design of Three-Hinged Arch With 616-Ft. Span—Floor 467 Ft. Above Low Water

A THREE-HINGED steel arch recently completed across Marble Canyon on the Colorado River 6 miles below Lee's Ferry, Ariz., will be the first bridge for wheeled vehicles in all the 600-mile length of this stream between Topock, Calif., and the junction of the Green and the Grand rivers in Utah, where the Colorado really begins. This bridge was urgently needed in order that a north and south highway between Arizona and Utah could be made safe and dependable by the elimination of a ferry and an extremely dangerous stretch of road within the canyon itself. The bridge is located 130 miles almost due north of Flagstaff, Ariz., which is the nearest railroad point. Because of this long truck haul, much of it over what was little more than a desert trail, more than ordinary consideration was given to the various types of bridges that might be selected and the weight of materials involved.

A suspension bridge was found to be too costly; a half through-arch would have required a heavy overhead cable system to carry the dead load of the entire span during erection and the entire cost of this overhead system would have been charged to the job because the cost of the 130-mile return haul would exceed its salvage value.

The final choice, therefore, was for a three-hinged deck arch, half of which could be erected from each canyon rim as a cantilever structure, making final closure in the center. This type afforded the advantage that members could be designed to withstand cantilever stresses during erection without any considerable increase of cost and most of the extra steel used temporarily in tie-backs, etc., later could be incorporated in the approach spans. These members intended for a dual function were designed so there would be as little field work as possible in converting them to the latter use. Eye-bars used in the tie-backs became the bottom chords or diagonals of the approach span trusses, in which the posts consisted of the bars used first in the erection toggles. These approach trusses were designed to use members of the exact length suitable for the tie-backs, packing rings being fitted into the eyes to compensate for the smaller pins required in the approach truss.

Some of the members of the approach trusses have a heavier section than would be required if it had not been necessary to use them as construction material. However, as the bids were taken on the basis of a pound price for steel, this plan resulted in a lower general price on structural steel than would have been obtained if erection material had not been used in the finished structure. Throughout the job there were the strictest economies in weight and the tonnage to be hauled in to the site was kept as low as possible.

The total amount of freight for the job, including cement for the foundation as well as all erection equipment and materials (but not cement for the bridge floor), totaled about 1,500 tons, of which 1,200 tons was structural steel. The hauling contract stipulated that 10 tons per day should be delivered to the job continuously except when rainy weather made the roads impassable. The contractor employed two six-wheel trucks of 10- and 3½-ton capacities respectively, both equipped with 40x8-in. pneumatic tires. Some of the steel pieces were 53 ft. long and the maximum weight in a single piece was

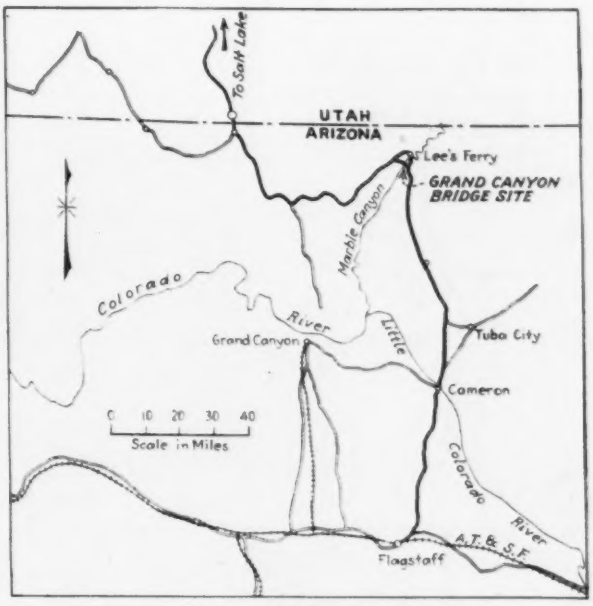
about 12 tons. These heavier loads required about thirteen to fourteen hours to make the trip.

The hauling contractor established a road camp about midway of the haul, and here the drivers changed shift. The extremes in temperature on this haul ranged from 110 deg. F. in the late summer to 16 deg. F. below zero in winter. Hauling through the snow would have been impossible were it not that the snow was confined to comparatively small areas at rather high elevations, and the hauling schedules were planned so as to cross these portions of the route at night, when the snow was frozen. The hauling contract was completed on schedule time and with the use of only the two trucks mentioned. Delivery of steel to the far side of the canyon was effected by a cableway slung across from the end of the first half of the arch on the south side.

In the canyon at the bridge site Kaibab limestone strata in horizontal layers afford ideal support as abutment footings. Niches were excavated on both sides of the canyon, care being taken to remove all loose or projecting rock to make sure that no slides or falling fragments would menace the completed structure. The estimate for this excavation was 9,000 cu.yd., but on the north rim a fissure was encountered entailing additional excavation and lengthening the arch span by 16 ft., and the total excavation was thus increased to 17,600 cu.yd. Only enough concrete was used to build up a footing of suitable shape under each truss, the total concrete for both ends of the bridge being not more than 100 cu.yd.

The main span, 616 ft. long, consists of 22 28-ft. panels. The roadway, 18 ft. wide between curbs, is 103 ft. above the bottom pins of the arch and 467 ft. above the river surface at low-water level. The total length is 834 ft., including two 84-ft. deck trusses on the north approach and two 25-ft. trusses at the south rim. The factors controlling the amount of rise in the arch were rock excavation and steel tonnage. An increase of the arch rise increased the rock excavation, and decreasing the rise increased the weight of steel required in the trusses. A 90-ft. rise from abutment pin to crown pin was found the most economical.

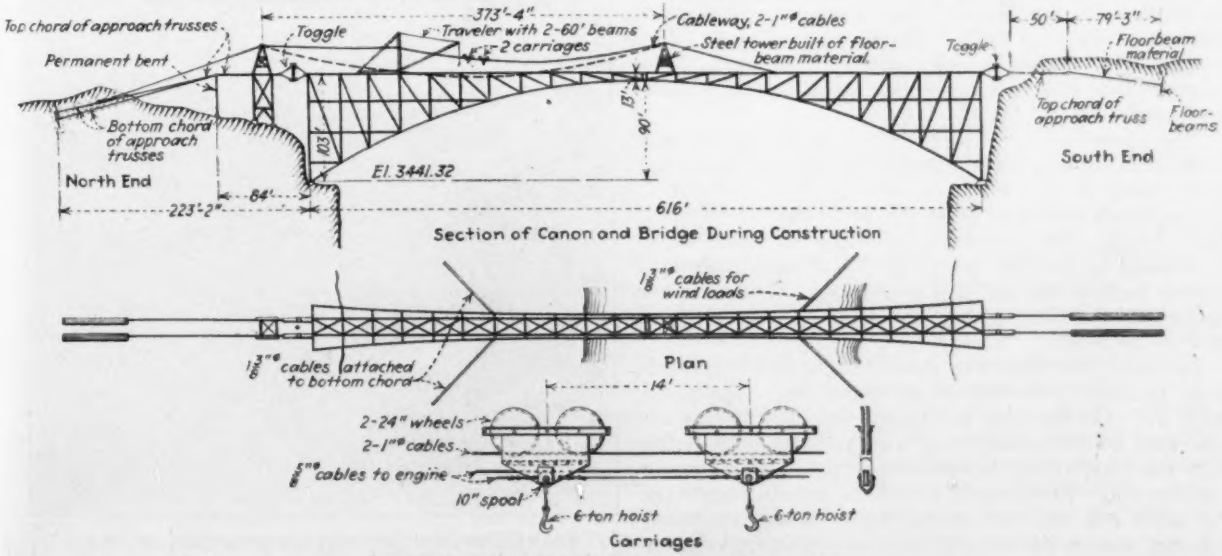
The main arch was designed for a uniform live load of 60 lb. per sq.ft. of roadway, or 15,000 lb. per panel point of each truss. The concentrated live load, and hence the basis for floor system design, was one 15-ton truck or two 12½-ton trucks side by side, allowance of 30 per cent being made for impact. The wind load was taken as 60 lb. per sq.ft. on the exposed area of one truss and 30 lb. per sq.ft. on the exposed area of handrail and floor system. To this was added 150 lb. per lin.ft. in the plane of the floor for moving load.



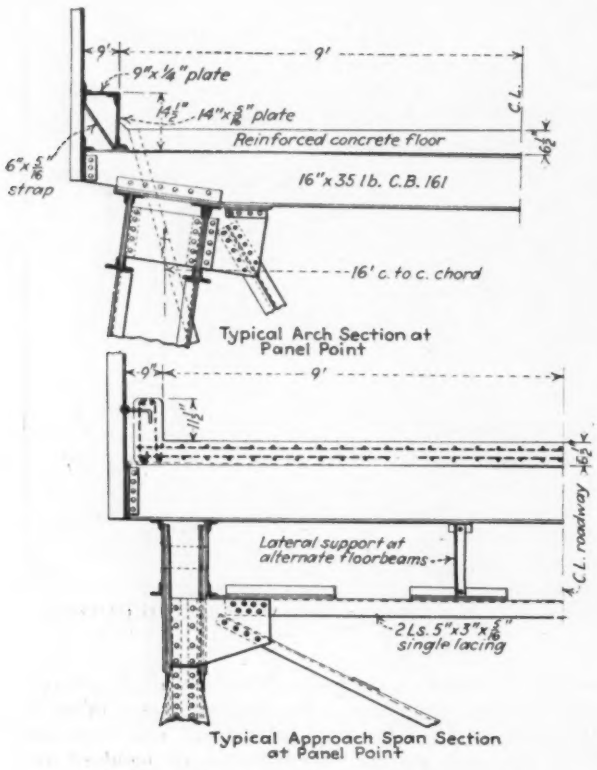
KEY MAP SHOWING LOCATION OF GRAND CANYON BRIDGE

The erection load was worked out to allow for the use of a 30-ton erection traveler, with 15 tons on each truss, or a concentration of 7½ tons on each of the two end panel points of each truss.

As first planned, the floor system was to be carried by longitudinal stringers over floor beams supported at the panel points. These plans were recast to utilize excess material required in the top chord during erection, the revised plans providing for a floor system supported on steel cross-beams spaced on 4⅔-ft. centers and bearing directly on the top chords of the trusses. This materially reduced the total amount of steel in the structure.



PLAN AND ELEVATION OF THE STEEL ARCH



FLOOR SECTIONS ON ARCH AND APPROACH

A steel curb built of angles and plates was used, because the steel curb weighed about 30 lb. per lin.ft., as compared with 100 lb. for a corresponding concrete curb. This effected considerable saving because of the moment involved in the long span. The reinforced-concrete curb was cheaper, however, and was used on the approaches. The steel channels finally used in the curb were first employed during erection as rails for the track on which cars of material were moved out over the cantilever section.

The bottom chord of the arch truss is a box member built up of angles and plates, the bottom or open side of the box being laced with 6-in. channels. The maximum section of this chord at the abutment is about 32 in. square and includes a steel area of 140 sq.in. The largest single piece of this bottom chord was 36 ft. long and weighed about 12 tons.

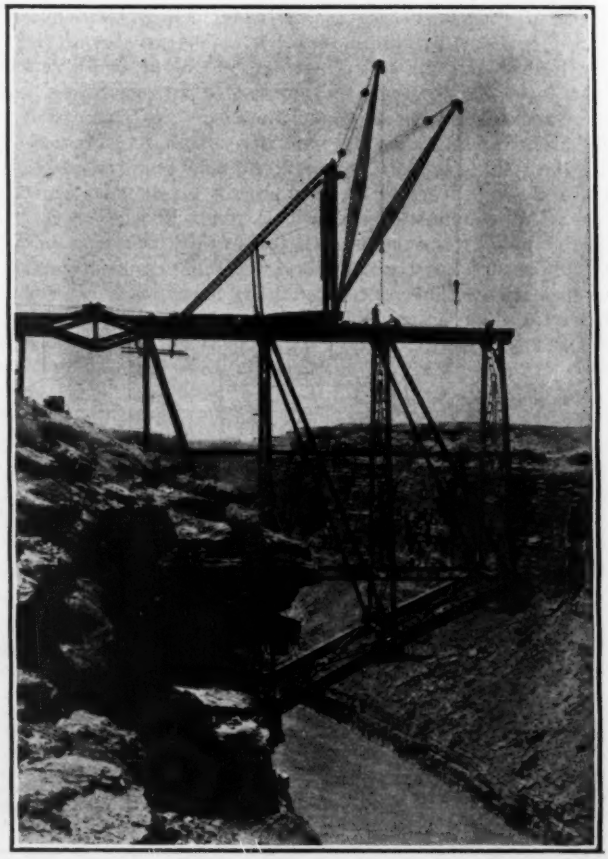
The scheme of erection involved a toggle joint in each truss. To connect the tie-backs with the top chord, the latter being in tension during erection, the top chord of the approach span was made similar to that of the arch, and through this member the entire erection stress amounting to 750,000 lb. in tension at each truss was carried back to the erection anchorages. These chords also carry the floor system on beams similar to those used in the arch.

Closure of the arch and connection of the two cantilever portions was effected by screw-jack toggles on Sept. 12. On that day the toggle screws on the south side were started at about 11 a.m. and this half of the arch was lowered 9 in. before operating the toggles on the opposite end. In the early afternoon lowering began on the north end and for several hours in the afternoon lowering was carried on simultaneously upon both halves in order to keep the pin sockets from binding on the pins which were secured in place in the steelwork of the south side. Final closure with both halves bearing on the pins was accomplished at about 5:30 p.m.

A notable point in this closure was the quick lowering of temperature after sundown, which caused the steel to contract so rapidly that it was necessary to continue the operation of the toggle screws until about 9 p.m. in order to prevent the toggles from again taking the stress of the center pin. According to calculations made at the time of design, temperature variations of 40 to 50 deg. F. would cause the span length to change nearly 2 in. After sundown on the day of the closure the toggle screws were operated as fast as possible to keep pace with the shortening. One of the screws on the north end was stiff and slow in operation and when it became apparent that it could not maintain the necessary speed, the screw was cut in two with the oxy-acetylene torch.

Due to the additional excavation that delayed work on the north half of the arch, it was known early in the construction period that the south half would be completed first. Hence final boring of the pin-bearing plates to go on the river end on the north half of the arch was not done in the fabricating shops when the other members were being finished. Instead, direct measurement was taken across the uncompleted portion of the span when the north half had approached to within three panel lengths of closure. This afforded a check on calculations and still allowed time to complete the shop work and get the final pieces on the job when they were needed.

First plans called for a timber floor because of the

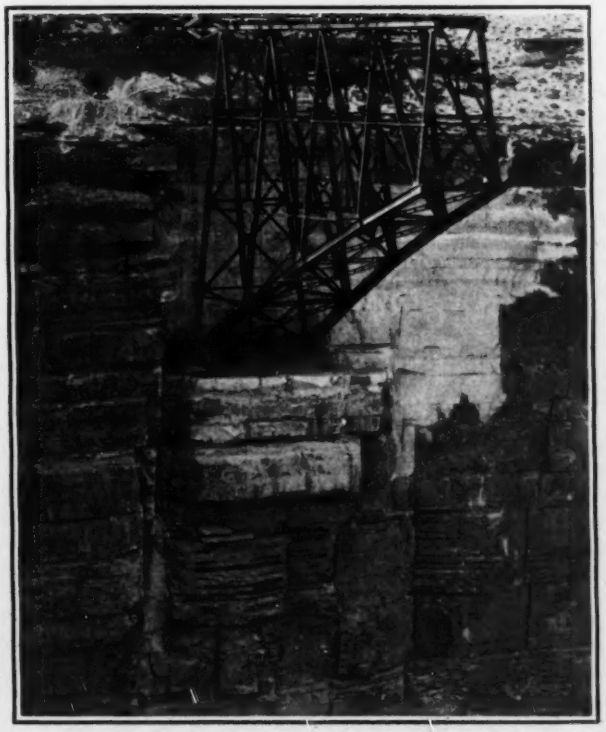


TRAVELER AT WORK NEAR SOUTH END OF ARCH
Note toggle in top chord and arrangement of double boom traveler. This view looks downstream.

SHOE AND THRUST FOOTING AT NORTH ABUTMENT

lighter weight and lower cost. However, the danger of fire in this remote location and the possibility that a floor system fire might endanger the entire structure made it desirable to use a concrete roadway. This was laid out as a 6½-in. heavily reinforced-concrete slab weighing 81 lb. per sq.ft. and spanning across the spaces between beams, which are 4 ft. 8 in. apart. The handrail will be of steel with posts resting on alternate floor beams—that is, 9 ft. 4 in. on centers. The latticed railing with steel posts will weigh about 45 lb. per lin.ft. The camber in the bridge is 15 in. at normal temperature.

For safeguarding the steel workers a hemp rope safety net was built designed to be slung under the cantilever span during erection. This was never used, however, partly because of the danger attending its erection and partly because of the frequent necessity for moving it as the work progressed. One steel worker fell from the bridge during erection. He was doubtless killed by the impact of the long fall and his body was never recovered,

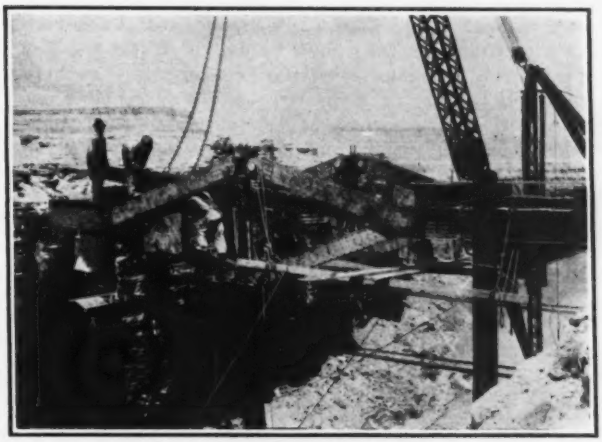


LOOKING ACROSS MARBLE CANYON TO NORTH ABUTMENT
All rock segments that might fall on the steel work were blasted out.

the river having considerable velocity in the canyon. The use of safety belts was required for all workmen on the structure other than the professional steel erectors, whose work required more freedom than the belt permitted.

The first money for the bridge was an appropriation of $100,000 authorized by the United States Congress in December, 1923, made contingent upon raising an equal amount by the State of Arizona. Ultimately, however, it was found necessary for the state to raise a total of $185,000, bringing the total available for completing the work to about $285,000. This would still have been insufficient, however, if the state highway department had not been able to finance the excavation and concrete footings independently.

Plans for the structure were developed by the officers of the Arizona State Highway Commission, W. C. Lefebvre, state highway engineer, W. W. Lane, chief engineer. Design and details were made under the direction of R. A. Hoffman, bridge engineer. The U. S. Bureau of Public Roads co-operated on the design and made frequent supervisory inspection during construction. R. C. Perkins was resident engineer in charge of construction for the State Highway Commission until July, 1928, when he was made district engineer in charge of construction and was succeeded by R. C. Bond as resident engineer. Contract was awarded to the Kansas City Structural Steel Company on July 29, 1927, with date of completion set for Sept. 1, 1928. R. A. Kizer, designing engineer, Kansas City Structural Steel Company, was resident in charge for the contractor.



SETTING UP TOGGLE AT SOUTH RIM

Extending Automatic Train Control

The railroads of the country have equipped 11,213.3 miles of road or 19,703.5 miles of main track with train-stop or train-control devices to Aug. 31, 1928, according to a report by the Interstate Commerce Commission. This includes 2,821.2 miles of road or 4,557.4 miles of track equipped voluntarily by the railroads in addition to the mileage ordered to be automatically equipped by the commission. Locomotives with automatic control number 8,496, of which 7,451 were so equipped under orders of the commission. The railroads voluntarily added 844 locomotives to the number requested by the commission, and in addition 201 foreign locomotives have been equipped for automatic operation over 545 miles of joint operated track.

Engineering Aspects of Railway Track Maintenance

Manganese Steel for Rails—Experience With Concrete Roadbed—Rail Laying in Winter —Wear at Joints

MAINTENANCE-OF-WAY in its technical and economic aspects, rather than as to its routine work, was stressed at the recent annual convention of the Roadmasters and Maintenance-of-Way Association, held at Buffalo, as will be seen by the following brief abstracts of some of the papers and reports presented:

Improvements in Rails—In a paper on the relations between the manufacture and service of rails, by C. B. Bronson, assistant inspecting engineer, New York Central Lines, it was stated that many experiments have been instituted to improve the physical and structural qualities of rail steel. In most cases the experiments have been abandoned because of higher cost or no appreciable improvement in service. However, two promising developments are the production of heat-treated rails on a commercial scale and the wider use of medium-manganese rails.

As to the latter, large tonnages have been installed by several roads during the past three or four years, including 85,000 tons on the New York Central Lines. The advantages of this steel may be summarized as follows: (1) Quiet setting in the molds indicates more complete deoxidation; (2) free flowing action of the steel in rolling; (3) lower percentage of seconds; (4) finer grain structure; (5) cleaner steel with decidedly less segregation in the "A" rails; (6) increased toughness and shock resistance; (7) elastic strength nearly 25 per cent higher than standard open-hearth steel, with correspondingly increased ultimate strength; (8) increased endurance limit; (9) less batter and chipping at rail ends and less transverse flow in surface of head; (10) lower rate of wear, particularly on the high rails of curves; (11) rail failures reduced, especially those from interior transverse fissures.

Preventing Damage to Rail Ends—This problem resolves itself almost entirely into a consideration of rail-joint maintenance, according to a committee report presented by C. F. Allen, division engineer of the Chicago, Milwaukee, St. Paul & Pacific Railway. With rails properly laid, their life in the track depends upon the attention given to maintenance, especially at the joints, including joint ties. Rail battering can be minimized by keeping the joints tight enough to develop this strength, but not so tight as to prevent uniform distribution of expansion and contraction movements in the rail.

The percentage of rails damaged by end flow and subsequent chipping is very high. This damage is due to rails being too tight or too close together, resulting in flow of metal from one rail to the other. When the rails contract and separate in cooler weather, this metal is forced out, leaving chips in the ends of one or both rails. Some roads require the section forces to watch for this end flow and cut it off in winter, when the joints are open. Other roads bevel the rail head for $\frac{1}{8}$ in. back from the end and to a depth of $\frac{1}{2}$ in. Reconditioning the rails by building up battered ends by welding is practiced by most railroads and is increasing. It is more economical than cropping the ends and re-rolling. In many cases, the battering is prevented or materially retarded by the application of new angle bars or rail-joint shims. This is desirable before building up the rails by welding.

Laying Rails in Winter—The advantages of this practice are apparent, provided the work can be done well and economically, according to the report of a committee headed by M. J. Nugent, assistant engineer, Delaware & Hudson Railroad. The question is whether these benefits are greater than the handicaps imposed, especially on Northern railroads. The principal reasons for doing as much work as possible during the cold season are: (1) It reduces and advances the work of the following spring and summer; (2) a more adequate and efficient labor supply is available; (3) traffic is usually lighter; (4) a more evenly balanced track force may be maintained during the entire year. Special methods and precautions for winter work were reviewed in the report, the conclusions of which were as follows:

"Members of the committee differ as to the cost and quality of winter rail laying, but those who have gone into the matter thoroughly are satisfied that both of these factors compare favorably with work done during the summer. While the cost in some locations may be somewhat higher, the small increase is more than offset by the advantages."

Experimental Concrete Roadbed—In a paper by Paul Chipman, valuation engineer of the Pere Marquette Railway, on the experience with a $\frac{1}{4}$-mile stretch of track with rails laid on concrete slabs, the conclusion was that while such construction must be developed by trial and error, there is nothing in the experience so far to discourage the belief that a roadbed of this type may be evolved which not only will be satisfactory in performance but will result in such a saving on heavy traffic roads as to justify its cost of installation. It is considered that in a design as modified by experience this cost may be $40,000 or $45,000 per mile, including fastenings, but not including rails.

After 21 months' service the track rides smoothly. There is very little battering of the rail ends, but there is some cupping, with a depression which begins 3 or 4 in. from the receiving end of the rail and extends 10 to 15 in. The bolted fastenings were not sufficient to prevent creeping of the rails, but this movement was checked by anchoring the rails on the approaches to the concrete section. One line of rails rests on a $\frac{1}{8}$-in. strip of insulating fiber, which not only provides insulation but also reduces the noise of passing trains, gives a better grip for the bolt fastenings and protects the concrete from abrasion. However, there is little evidence of abrasion under the rails which rest directly on the concrete. A train resistance about 0.8 lb. per ton less than on ordinary track has been determined by some rather crude experiments.

A total settlement of $1\frac{1}{2}$ in. has taken place in the slabs, but is very uniform. Loading tests with a 204,000-lb. switch engine showed a practically uniform deflection at the slab joints, averaging 0.08 in.

Track Work Problems—Economy and efficiency in track work may be increased and interference with traffic reduced by preparing a seasonal program, according to a committee report presented by J. J. Desmond, Illinois Central Railroad. But it was pointed out that the roadmaster and foremen must co-operate in planning such a program and must adhere to it as closely as possible. One of the best methods of keeping an accurate, convenient and up-to-date record was said to be the use of daily reports from the foremen. A chart of the maintenance program should be kept by the roadmaster, show-

ing the amount of rail to be laid, the number of ties to be installed, the amount of light and heavy surfacing and similar items. Progress should be marked on this at frequent intervals, so that it shows how the season's schedule is being adhered to, what the track conditions are and where the work is falling behind the schedule. The different kinds of work and the progress made may be shown on the chart by colors.

Organization of Track Forces—To determine the number of men for a track section, the most accurate general rule is to decide upon the quality of maintenance desired, estimate the labor cost of such maintenance on a mile of main track, and estimate the cost of other units of track work, the several costs being then equated for a section of given length. This report, presented by A. A. Johnson, track engineer of the Delaware, Lackawanna & Western Railroad, stated that experiments are being made with doubling up two sections and their gangs as one unit. But there is a difficulty in getting section foremen competent to handle the large gangs. In the discussion it was stated that one road proposed to try the plan of a large floating gang to handle the heavier work, while only the watching, policing and light work would be left to small section gangs. This plan has been tried in France.

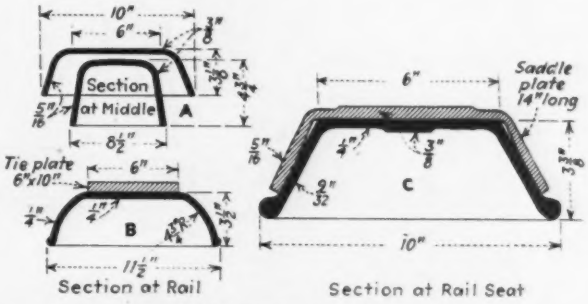
Handling Maintenance Materials—Distribution of materials for maintenance-of-way has become a serious burden to the railways in view of its interference with traffic and the use of cars which might otherwise be in revenue service. This report, by a committee headed by R. H. Smith, superintendent, Norfolk & Western Railway, outlined these difficulties and suggested some remedies, but it dealt only with rail transport, although some roads have tried road transport. Where freight cars are used, they should be loaded, hauled, unloaded and released as quickly as possible. Some railroads use old cars for work trains and company service, but there are limitations to this practice if the cars have to be hauled in regular freight trains. With the increasing introduction of motor section cars a considerable reduction in cost of distributing material has been effected, particularly on lines of light traffic, by using motor cars and trailers for assemblying materials at sidings or other distribution points and for distributing material from these points.

St. Louis Proposed Riverfront Improvement

In order to have the advantage of a waterfront recreation space and also to improve traffic facilities, the City Plan Commission of St. Louis, Mo., has submitted a report on a project for a 140-ft. double-deck thoroughfare along the present Third St. and the development of the space between this street and the river, from the Eads bridge south to the Municipal bridge, as a park and plaza on the upper level. Ramps would lead to the lower level streets and to the levee. Beneath this plaza would be a garage, public parking space, subway terminals and other facilities. The 140-ft. street would connect with the bridges and would be approached from the south and north by new 100-ft. double-deck thoroughfares. Property on the proposed site has deteriorated in value lately, owing to the shifting of the business district and the growth of the city. The cost is estimated at $50,000,000 by Harland Bartholomew, engineer for the commission, and it is suggested that this amount may be raised partly by a bond issue and partly by special assessment on property benefited.

Reinforcing Steel Ties in India

IN STEEL TIES of the inverted trough-section known as the peapod type and used extensively on railways in India, there has been trouble due to crushing and failure in the end portions under the rails and to spreading of the sides of the trough under heavy loads beyond those for which the ties were designed. There has been difficulty also in effectively tamping the ties, the sides being nearly vertical. On the Bengal-Nagpur Railway, 5 ft. 6 in. gage, having about 822 miles of track laid with these ties, a heavier section was introduced (shown at *A* in the accompanying drawing) when 90-lb. rails replaced 75-lb. rails, but these did not eliminate the troubles. Failure at the rails resulted partly from wear



STEEL TIES FOR BENGAL-NAGPUR RAILWAY
A—Peapod type of tie for 90-lb. rails. *B*—Modified tie with tie-plates. *C*—Experimental tie with saddle plate at each rail.

due to direct contact between rail and tie, and partly to the top table being weakened by punching up four lugs to serve as rail fastenings. Metal wedges or keys are driven between the lug and rail base.

A modified section was designed, therefore, and laid for about half a mile on a stretch of double-track line. In this tie (shown at *B* in the accompanying drawing) the sides were sloping throughout and were reinforced with a bead on the edges; heavy base plates were placed between the rails and the tie, while bolts were substituted for the wedge fastenings. These ties, weighing 135 lb. with tie-plates, have proved satisfactory under axle loads of 16¾ tons, but as loads of 25 or even 30 tons are contemplated, it is thought that stronger ties will be needed.

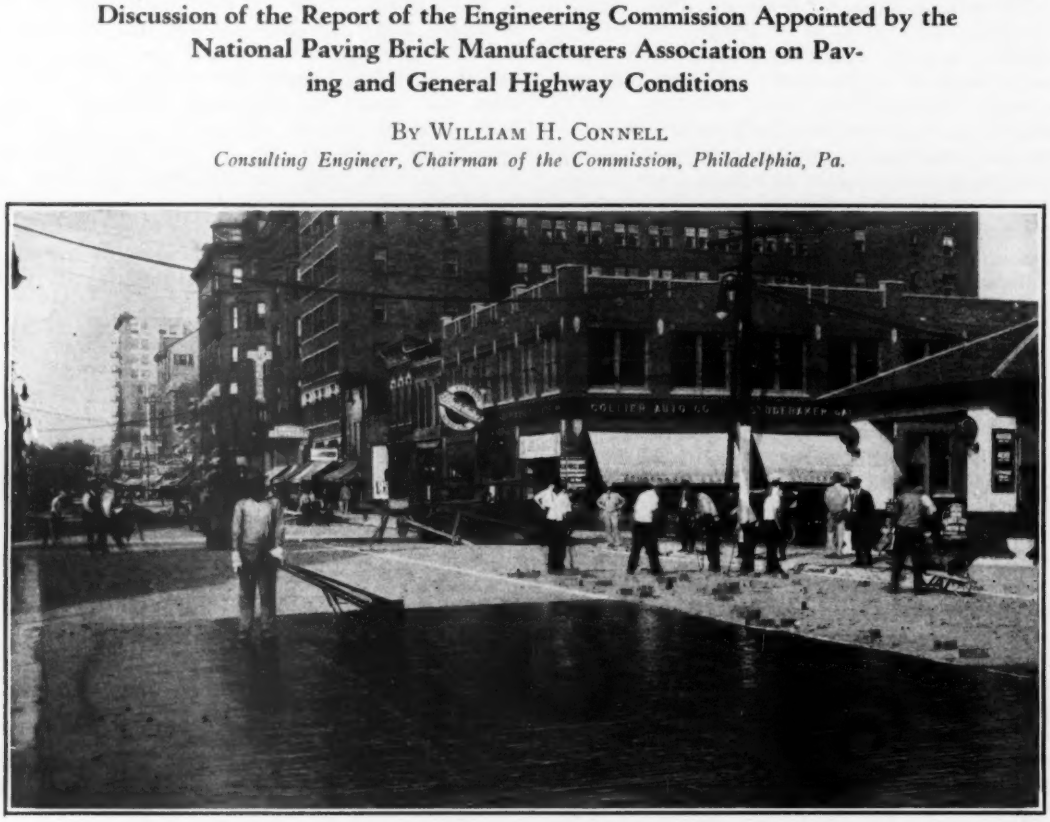
To meet this condition, the reinforced design shown at *C* in the drawing has been proposed. Here the special feature is the replacement of the ordinary tie-plates by saddle plates, straddling the tie and thus distributing the load over the sides as well as over the top of the tie. Bolted fastenings are used. For ordinary trough ties to carry 25-lb. axle loads, without tie-plates, it is stated that the weight would have to be about 200 lb., exclusive of fastenings. If tie-plates are used, permitting thinner metal in the tie, the combined weight of tie and two plates would be about 195 lb., a saving of only 5 lb. But with the saddle plates carrying the rails, distributing the load over a larger area and preventing the sides of the trough from spreading, the experimental tie weighs about 126 lb. and the combined weight of tie and plates is only about 160 lb. The saddle plates could be shaped readily from old steel ties.

This new form of tie is described by F. S. Hughes in a paper on "Steel Sleeper Design" published in pamphlet form (Technical Paper 260) by the Railway Board, Delhi, India.

A Survey of Brick Pavement Performance

Discussion of the Report of the Engineering Commission Appointed by the National Paving Brick Manufacturers Association on Paving and General Highway Conditions

By William H. Connell
Consulting Engineer, Chairman of the Commission, Philadelphia, Pa.



APPLYING ASPHALT FILLER ON MODERN BRICK PAVEMENT

AN ANALYSIS of the vitrified brick paving situation shows the economic value of vitrified brick pavements when constructed in accordance with modern methods—that is, with an adequate foundation, a thin sand cushion and an asphalt filler—and when used under the traffic conditions for which the pavement is suited.

This statement is not only supported by the facts developed through this investigation but it is confirmed by the results of tests and investigations, notably the Bureau of Public Roads tests and the Bates road test. It is also supported by statements of engineers and officials with respect to the traffic service value and low maintenance costs of many vitrified brick pavements from 20 to 40 years old. The value, therefore, of this type of pavement resolves into a question of proper construction methods and proper use.

Causes of Unsatisfactory Brick Pavements—Unsatisfactory brick pavements are almost entirely due to four causes: (1) Poor construction; (2) either no foundation, or one that is inadequate for the traffic; (3) poor sub-soil conditions; and (4) specification requirements that have proved undesirable, such as the monolithic construction, the grout filler, and the thick sand cushion. Sand fillers are also undesirable except in climates where there is no frost and where a brick pavement is used in progressive construction.

There also are instances where bricks unsuitable for pavements have been used. The closer attention to manufacturing details and the stiffening up of the specifications a number of years ago has taken care of this situation and there is no reason now for accepting poor paving bricks.

Adequate Foundation—As a result of the study great stress must be laid on the necessity of an adequate foundation for a brick pavement. In recent years many such pavements have been constructed with inadequate foundations merely to reduce the cost. No greater mistake was ever made in the highway business.

Asphalt vs. Grout Filler—The condition of the old asphalt-filled brick pavements that were inspected indicates that with this construction brick pavements will last many more years than if a grout filler is used.

Grout filler has been the cause of longitudinal cracks in most of the pavements constructed with it. There are also many instances where the impact from the traffic has caused the brick adjacent to these cracks to shatter. There are, however, a number of examples of pavements constructed with a cement grout filler from 15 to over 20 years old that are in practically perfect condition and have had but little or no repairs and are apparently good for another 20 years or more.

Life of Paving Brick—An inspection of the brick in pavements, some of which are 40 years old, proves that a well-manufactured paving brick will not only render satisfactory service under heavy traffic but due to its long life will make an economical pavement under medium traffic. It also has the added advantage of not being affected by the elements or destructive effects due to chemical action. While the traffic was not as great in

volume prior to the advent of the automobile, it was harder on bricks because it was narrow, steel-tired traffic, so these old brick pavements have received considerable punishment and still in innumerable instances a great percentage of the bricks can be relaid and will render many more years of service.

Inspections were made of many relaid brick pavements that had given from 20 to 35 years of service before relaying and they are apparently good for from 20 to 35 years more service. The salvage value of the old bricks in these relay jobs was about 80 per cent.

It seems to be the general custom not to spend money for repairs on the old uneven brick roads and streets laid without a suitable foundation. This is probably due to the fact that unless relaid with an adequate foundation they cannot be kept in good repair, and the cost of constant repairs is prohibitive. The value of paving brick in this connection has been very largely overlooked. There are innumerable instances where the old bricks were in good condition for relaying and were sold for a very small price or were resurfaced with asphalt.

Arlington Road Tests—The Arlington test conducted by the Bureau of Public Roads, described in *Public Roads* of September, 1926, shows the long period service value of vitrified paving brick 2½, 3, 3½ and 4 in. thick. The report states that the actual traffic on the test section was equivalent to 18 years' average truck traffic on all the Cook County highways. After the completion of the tests the sections other than the 2-in. brick were in almost perfect condition.

Chevy Chase Road Tests—In 1913 the Bureau of Public Roads built an experimental vitrified paving brick section on what is known as the Chevy Chase experimental road on Connecticut Ave., Chevy Chase, Md. The brick were laid on a 6-in. concrete foundation and a 2-in. sand cushion. A cement grout filler was used.

The experiment is described in detail in the May, 1928, issue of *Public Roads*. The following statement is from this report:

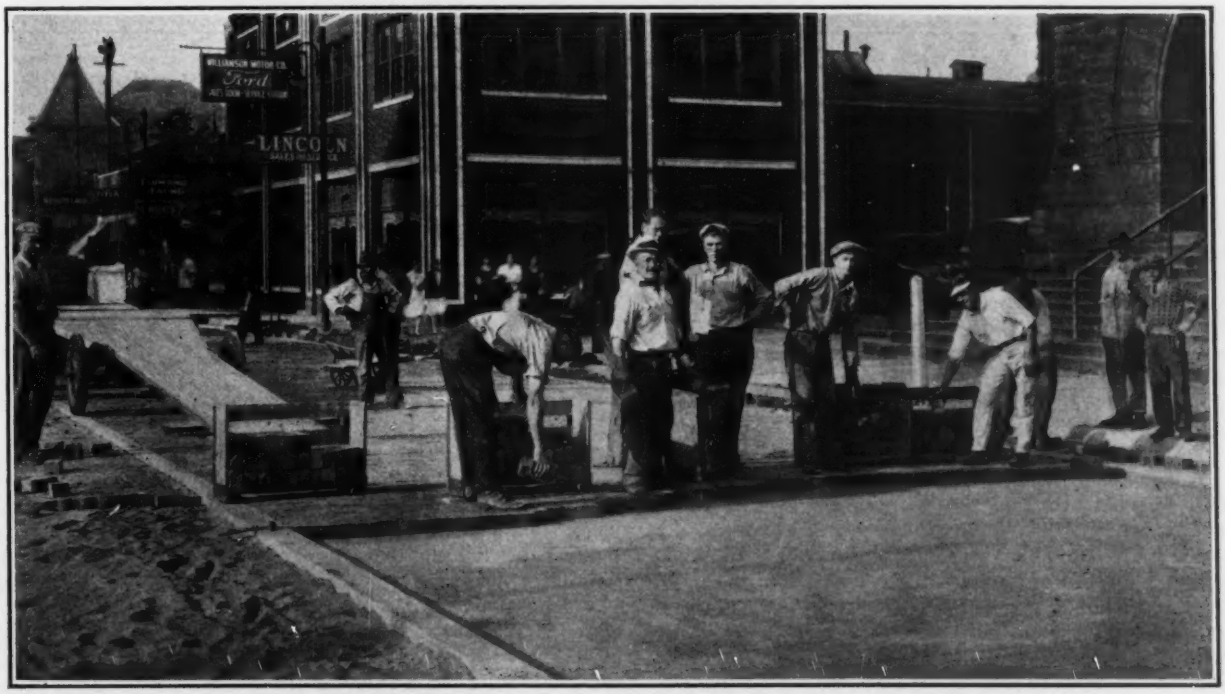
> No transverse cracks exist in the experiment, although a considerable number of fine longitudinal cracks have developed and sometimes extend through several consecutive sections. However, they seem not to have affected the behavior of the wearing surface, which still remains in excellent condition and shows no evidence of raveling. Except for the repair of defects directly caused by sub-grade and foundation failure, maintenance on this experiment has been confined to the filling of these cracks with bituminous material.

Bates Test Road—Referring to the brick sections, the following statement from the Illinois State Highway Department is quoted in the report on the Bates road tests:

> Observations of the test sections while traffic tests were being carried out, as well as observations of those portions of the road which are still in use as a part of our bond issue route 10, show that the individual paving brick stood up satisfactorily and that the failure of the brick sections was due to the failure of the supporting base rather than of the surface itself. Of course the bases used in the various test sections varied in thickness and proportion so that we were able to observe the load-carrying capacity of the different cross-sections.

So far as the brick sections were concerned the two things brought out by the test and which are a matter of record are: (1) That the brick stood up under the traffic tests and are continuing to render satisfactory service on the portion of the road where the foundation has not failed. (2) It is a waste of money to construct a pavement with a wearing surface of vitrified paving brick on an inadequate foundation.

A great many brick pavements from 5 to 15 years old that were constructed on an adequate foundation with an asphalt filler and a thin sand cushion were inspected by the commission. Practically all of these pavements were in first-class condition and had had little or no maintenance and will undoubtedly render a long period of years of traffic service. If the brick pavements that have been relaid, many of which were 30 and 35 years old, had



SAND CUSHION FOR A MODERN BRICK PAVEMENT

Note the racks in which the brick carefully stacked are served to the layers, who work in pairs from curb to crown and return, and note particularly the exactness with which the thin sand cushion is finished to profile.

been originally laid on an adequate foundation with a thin sand cushion and an asphalt filler, the indications are it would not have been necessary to relay them.

Financial Advantages of Long Life—The inconvenience and additional operating costs incurred by motor vehicles due to reconstruction on a highway carrying considerable traffic and the inconvenience to abutting property and the loss to business interests in built-up localities are so great that pavements with a very long life and requiring the least amount of repairs are the cheapest when all costs are considered. Under such circumstances a pavement with a long life is justified, even though the ultimate cost of the pavement is greater than the cost of two or three less durable pavements for the same period of years.

It has been shown that the average motor vehicle operating cost for each 1,000 ft. over a hard-surfaced rural road is approximately $0.023.

SURFACE OF BRICK PAVEMENT FOURTEEN YEARS OLD, OMAHA, NEB.
Concrete base, sand cushion and asphalt filler.

To illustrate what a big factor transportation costs are in connection with the reconstruction of pavements, let us assume that the reconstruction of a mile of rural highway 18 ft. wide will necessitate a detour 2,000 ft. longer than the pavement under reconstruction. If the road is closed for 1½ months and the traffic consists of 5,000 vehicles a day, the additional transportation costs would be $10,580. The number of square yards in the pavement would be 10,560. The additional transportation costs, therefore, would amount to about $1 for each yard of pavement reconstructed. If the detour were a dirt road, the operating cost would be 25 per cent more, or equivalent to about $1.25 for each yard of pavement. This does not take into consideration the cost of loss of time, which is a big factor in transportation costs. It is easily seen that under such circumstances an additional cost of more than $1 a yard for construction of a pavement to obtain a long period of service without reconstruction would be an ultimate economy.

Several thousand miles of rural highways carry 5,000 vehicles and upward during the general construction season from spring until late fall.

In closely built-up communities the additional operating costs due to detours would be far greater, as there would in many instances not only be more vehicles but a greater percentage of trucks and buses. By using the factors in the above illustration and increasing the number of vehicles to 10,000 a day an additional first cost of more than $2 a yard would be an ultimate economy.

The financial loss to abutting property and business interests in built-up communities during reconstruction we know is very great. There is, however, no yardstick with which to measure it in dollars and cents, but it does not take an unusual imagination to visualize a substantial dollars and cents loss not only to each business establishment located on the street under construction but to many others carrying on business relations with them. Under the conditions under discussion the ultimate economy of a long-life pavement as compared with a shorter-life pavement, even though constructed at a substantially greater first cost, is plainly evident.

Vitrified brick pavements when constructed with a bituminous filler offer a very great advantage in instances where it is necessary to open the pavement for sewer, water, gas, service cuts, etc., or street railway track repairs. Each brick, being a separate unit, can be taken up and relaid without destroying the paving surface. This results in a very considerable saving of money, as there are always more or less service cuts in built-up communities.

The following general recommendations are made by the commission:

1. Vitrified brick for use in pavements should be thoroughly annealed, tough, durable, non-absorptive and uniformly burned and free from marked laminations. They should conform to the standard tests of the engineering societies and the sizes agreed upon by the Hoover committee.

2. The stability of a pavement depends on the foundation, and the local soil conditions must be considered in providing adequate drainage of the sub-grade. A stable sub-grade must be maintained under all weather conditions to insure a durable pavement. If the soil conditions are not favorable to proper drainage, it will be necessary

to provide material which will produce satisfactory drainage. The uniformity of a sub-grade vitally affects the durability of a base course, and for that reason great care must be taken to provide for the continuous and uniform compactness throughout the length of the pavement.

An adequate foundation for a brick pavement has been stressed. This term has been used, because it implies that the foundation must be strong enough to support the pavement under the different traffic, climatic and sub-soil conditions.

Where the traffic is light in sections where there is no

BRICK PAVEMENT LAID IN 1895 AT DIXON, ILL.
Macadam foundation and sand filler.

frost, a well-drained sand or gravel sub-soil may serve as an adequate foundation. Old stone, slag and gravel roads are also adequate under certain traffic conditions. Bituminous concrete foundations are also used. Florida limerock and chert foundations are used in some of the Southern states.

The generally accepted foundation where there is any appreciable amount of traffic is concrete, and this will vary in thickness as well as in the mix used under the different traffic, climatic and sub-soil conditions. There is no such thing as a standard adequate foundation. The facts in each instance should govern the determination of the strength of the foundation, but nothing should be overlooked to insure its being adequate.

The actual surface of the foundation should be smooth. Variations shown by a 10-ft. straight-edge should not exceed $\frac{1}{4}$ in.

3. The type of curb must meet the requirements of each particular job. Concrete curb should not be less than 6 in. in width. Steel curbs may be employed and the brick surfacing placed at the edge of the concrete base.

4. A sand or granulated slag cushion not exceeding 1 in. and preferably $\frac{3}{4}$ in. in depth has proved to be the most desirable bedding course.

5. It is essential that brick should be laid in a manner, either by the use of a lug or otherwise, which will definitely provide a sufficient space between them for the application of the filler. The filler should fill the space between the bricks from the top to the bottom of the bricks.

The 10-ft. straight-edge should be in constant use to obtain smooth and uniform surface, and the rolling should be continued until satisfactory results have been accomplished.

6. An asphalt filler has proved to be the most satisfactory and is recommended for general use. Investigations should be made by the engineering societies to determine upon a standard specification for a filler best adapted for this purpose.

It is essential that the temperature of the filler should be such that it will readily fill the space between the bricks. The asphalt filler should not be applied when the bricks are damp or cold. Under such circumstances, provision must be made for heating and drying the pavement.

Wet Tunnel Strengthened and Made Tight by False Roof

Flat Concrete Roof Placed Under Old Arch Where Headroom Permitted — Waterproof Plastering Used Elsewhere

By S. E. Berkenblit
Structural Engineer, Chicago

WATERPROOFING and reinforcement of an old tunnel has been carried out successfully for the Kansas City Public Service Company in connection with the establishment of a rapid-transit route between the cities of Kansas City, Mo., and Kansas City, Kan. Difficult construction work on the elevated structure extending from the west end of this tunnel was described in *Engineering News-Record* of Oct. 18, p. 583.

The old rapid-transit line, built in 1887 and afterward abandoned, included a brick-lined double-track tunnel 736 ft. long through the bluffs, on the line of Eighth St. It was 22 ft. wide, with a height of about 15 ft. from top of rail to crown of arch. Originally the grade was 8.65 per cent, but in 1904 this was reduced to 5.51 per cent, the west portal being retained and the tunnel extended 325 ft. east to a new portal, beyond which wing walls extend 500 ft. in open rock cut.

This alteration of the tunnel entailed cutting a new floor 5 to 20 ft. below original floor level. All the new work was cut through solid rock and the old tunnel section was permitted to remain in place, the new rock walls being faced with concrete to give a more uniform surface. A new roof, consisting of a flat reinforced-concrete slab, was built in the east half of the tunnel. The present tunnel has a total length of 1,110 ft. between portals and an average width of 22 ft. Prior to the recent reconstruction it comprised 360 ft. of old semi-circular brick arch roof section and 750 ft. of concrete roof carried by the rock walls.

Careful examination of the tunnel during the summer of 1927 showed severe leakage in practically 75 per cent of the old brick-lined section and at numerous locations in the concrete roof and rock walls of the newer section. Water was not only leaking through the brick joints but was percolating through the bricks, indicating high heads. Various plans were considered for diverting the water to drainage channels, as continuous seepage through the brick would be detrimental to the strength of the arch.

In proposals obtained from several waterproofing

companies the essential feature of each was a thorough sandblasting of the walls and roof, removing loose cement and masonry and covering the entire surface either with cement by means of a cement gun or with a plaster of waterproofing compound. All the methods proposed were expensive and the engineers considered that they were inadequate in view of the inherent structural weakness of the tunnel section, the occasional bulging out of portions of the roof arch and the heavy discharge of water. It is evident that a structurally strong background is essential to any waterproofing protection applied to the inner surface. Consequently all proposals were rejected and a solution was sought which would give a satisfactory result at reasonable cost.

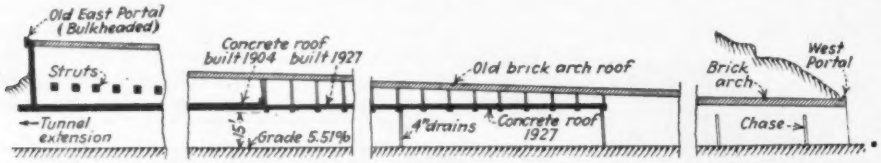


FIG. 1—TUNNEL WITH DIAPHRAGM ROOF AT KANSAS CITY, MO.

The east portion of the tunnel was a double-deck structure for 427 ft., as described and as shown in Fig. 1, a concrete roof being carried below the brick arch. After the abandonment of the line some years ago, the space above this concrete roof has been used for growing mushrooms, for which purpose the roof carried a heavy earthfill. This fill held ground and surface water, which seeped through the old brick arch, drained in through the old east portal, and also percolated through the concrete diaphragm roof and walls of the lower section. As a first step, the entire fill was removed from this level, and the roof slab was then thoroughly cleaned and waterproofed. Suitable drainage to the floor level was provided, while new wings and a bulkhead were built at the old east portal to retain the earth and prevent entrance of water. The results were satisfactory and all leakage has been eliminated from this portion of the tunnel.

For about 150 ft. beyond this double-deck section, water was seeping continuously through the old brick arch and dripping onto the tracks, making an objectionable condition for operation. Due to the lowering of grade in 1904, there was an excess of headroom available for a distance of 200 ft. It was decided, therefore, to continue the intermediate roof slab construction as far as headroom would permit, thus providing a drainage outlet for water entering through the old brick arch. This roof (Fig. 2) consisted of a 6-in. reinforced-concrete slab on beams supported in pockets in the old brick walls. The slab is of sufficient strength to carry any fall of the old brick arch, but during construction of the new work the arch was braced by timber sets spaced 10 ft. c. to c., to guard against accidental falls. The new roof is provided with drains leading to the tunnel floor drainage system and is covered with a waterproofing compound.

For the 160 ft. of the old tunnel between the new construction and the west portal, with the old brick arch and walls, the first 80 ft. was in good condition both structurally and as to leakage. For about 75 ft. at the portal, however, it was subject to considerable leakage. The headroom being too low to install an intermediate roof, it was decided to sandblast thoroughly the old masonry surface, clean out joints, remove disintegrated material and apply a waterproofing plaster. This treatment, shown also in Fig. 2, was applied to the entire 160 ft., except that in the first 80 ft. the waterproofing was applied only over sections where leakage was evident, while on the remaining 75 ft. the arch and walls were completely covered with waterproofing having a minimum thickness of ½ in. In order to relieve hydrostatic pressure behind the walls and arch, drainage chases were cut into the old masonry, extending up from the base of walls and around the arch ring.

Successful results have been obtained in all sections of the tunnel. The total cost amounted to about $15,000, as compared with original bids ranging from $35,000 to $50,000. William G. Woolfolk & Company, Inc., Chicago, were the engineers. The construction work was handled by the railway company's forces, except that the waterproofing of the west section was done by the Permanent Waterproofing Company, Chicago.

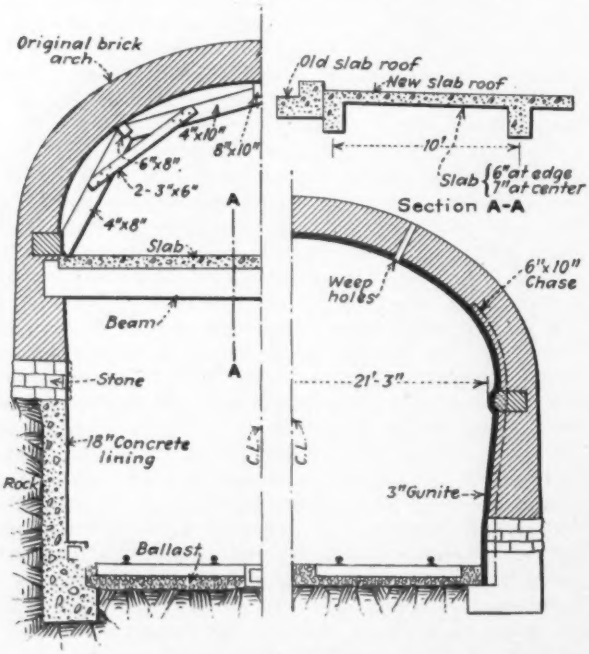


FIG. 2—TUNNEL SECTIONS SHOW WATERPROOFING
At left: New waterproof roof slab, with timber bracing for old arch. At right: Waterproof lining on old tunnel masonry.

Plan to License Aircraft as Common Carriers

Three committees were appointed by the California Railroad Commission recently to draft legislation relative to state control of air transport companies. One of the committees will give attention to needed laws covering inspection and licensing of aircraft, pilots, airports, etc.; a second will consider legislation affecting the regulation of aircraft as common carriers, such as financing, issuance of permits to operate, fixing of rates, routes, schedules, etc.; the third committee has to do with legal responsibility, liability insurance, etc., with special reference to aircraft.

This work is being done with a view to the probable necessity for putting air transport companies under regulatory jurisdiction of the State Railroad Commission.

Geology as Related to High Dams

Rock Conditions That Bear on the Choice of Dam and Reservoir Locations—Canyon Structure—Strength, Permeability and Solubility of Rocks—Softening in Water—Fault Movement and Earthquake Hazard

By F. L. Ransome,
Professor of Economic Geology,
California Institute of Technology, Pasadena

(A paper read at the San Diego meeting of the American Society of Civil Engineers, somewhat condensed).

THE fundamental requisites in the rocks at a site for a high dam are that the rocks be strong enough to withstand the stresses transmitted from the structure, that they be reasonably impervious, that they neither change in volume nor soften nor dissolve under the action of water and that they be not subject to such movement as would damage or destroy the structure.

Reservoir Conditions

Failure of a reservoir, where the dam remains intact, is rarely catastrophic. It may, however, mean the loss of valuable water or such large leakage that the reservoir becomes wholly useless. Porous rocks, provided the open spaces are not so connected as to form continuous channels, need cause no concern. Freely permeable rocks and soluble rocks, however, require particular attention and must be considered in relation to the geological structure of the region.

A permeable bed which outcrops in the reservoir and, maintaining a regular dip, appears again along the banks of a stream a few miles distant at a lower elevation would conduct water away from the proposed reservoir, whereas if the permeable bed is dislocated by a fault or so folded that there is no hydraulic gradient to any lower outcrop it might not permit any serious leakage.

Among the soluble rocks most likely to require attention are gypsum and rock salt. The McMillan reservoir, near Carlsbad, N. M., is a partial failure because the water escapes in large quantity through underground channels in gypsum, and these are increasing in size. On the other hand, Willow Lake, another reservoir, about 20 miles south of Carlsbad, is inclosed by gypsum but has shown no leakage since the dam was built, some five years ago. The difference is probably to be explained by the supposition that in the case of the McMillan reservoir there was initially a small natural solution channel through the gypsum, which the water escaping from the reservoir rapidly enlarged by the solution, whereas at Willow Lake no such passage exists and although gypsum is going into solution all around its shore this general solution has not led to any leakage. Rock salt is, of course, even less trustworthy.

Dam Site Topography

A dam site is usually a narrow canyon above which the stream flows through a valley or basin. The existence of a steep-walled, narrow canyon generally indicates that the rock at the canyon is harder than the rock in the upstream valley. This indication and the fact that canyons are geologically youthful features determine the favorable condition that the rocks in canyon walls are as a rule well exposed and relatively fresh, particularly near and under the stream.

It is advisable, however, to determine why a stream, as is frequently the case, forsakes an apparently easier course and turns aside to cut a canyon through hard rock. It is particularly important to ascertain whether this apparent preference is due to a fault or other particular line of weakness along the canyon and concealed by the sand, gravel and boulders of the present streambed. As a rule the courses of faults are more nearly rectilinear than are the courses of streams. Consequently the presence or absence of a fault along the bottom of a canyon can usually be determined by an examination of spurs and ridges that extend across the prolongation of a line drawn through the part of the canyon at the dam site. For example, at the Owyhee dam site, in eastern Oregon, the drill records suggested the presence of a fault under the river. Examination of the ground showed a little ravine and saddle, in line with the gorge, and the suggestion was made that a trench be dug across this ravine with a view to exposing the fault zone. The fault was found, as expected, and provisions to deal with it were embodied in the design of the dam.

Rock Strength

It may fairly be assumed that the rocks at a dam site should be at least as strong as the material of the dam. Ordinarily this means at least as strong as good concrete. The actual strength of sound samples of the rock can readily be determined by the usual engineering tests. It is for the geologist, however, to point out the bearing of geological structure on the strength of the rock-mass as a whole.

The St. Francis dam is believed to have failed first at its northwestern abutment, but the southeastern abutment was of little better quality. The dam at that end was built against schist in which the thin laminations stood nearly parallel with the slope of the canyon wall. The concrete was poured against the smooth cleavage faces of the schist and adhered to them, but there was little more adherence between the schist laminations themselves than between the sheets of a pile of paper.

Permeability

The slow seepage of water through a porous but insoluble rock, such as a spongy lava, may cause no important loss from the reservoir, is more likely to decrease than to increase and can do no harm. On the other hand, even a small leakage through rocks that are partly soluble may so weaken the foundations of the dam as to cause disaster.

The characteristic feature of a fault is a seam of clay-like material, known as gouge, which has been produced by the grinding together of the rock walls during the movement on the fault. The seam of gouge may range from a fraction of an inch to 8 ft. or more in thickness. It is usually accompanied on one or both sides by a zone of shattered or crushed rock. The gouge is usually im-

pervious, but the shattered rock is likely to be freely permeable. Consequently faults, where present, must be considered as probable paths of leakage.

Joints are relatively short fractures along which there has been no appreciable movement of one side of the crack past the other. Consequently they contain no gouge. Joints are present in most rocks, and, when long exposed to the weather, as in canyon walls, they become superficially accentuated and give such an alarming appearance of general fragility to the rock-mass as has led some engineers and geologists to condemn particular sites.

Solubility

Probably no rock is completely insoluble under all conditions found in nature. The solution of rocks such as granite, quartzite and basalt, however, is so slow or so slight as to be practically negligible. On the other hand, rock salt and gypsum are dissolved so rapidly in flowing water as to make them utterly unfit for the foundation of a high dam. Limestone and marble occupy an intermediate position between these two groups. Limestone is geologically soluble, especially in water containing carbon dioxide. Yet, with proper precautions against leakage, it would be practically safe to build a high dam on compact limestone.

The fact that calcite or calcium carbonate is the most common cementing material in ordinary sandstones and conglomerates lends particular importance to the question of the solubility of this substance. Many such sandstones and conglomerates are fairly resistant to weathering and stand out from the surface in bold outcrops. Nevertheless the questions may be asked: Are such rocks, with a calcareous cement, suitable for the foundation of a high dam? Will water, seeping through the rock under pressure, dissolve enough of the calcium carbonate to weaken the rock seriously or to destroy its coherence? Quantitative data to answer these questions are apparently lacking, and there is an opportunity here for some experimental engineering research. In the meantime the opinion may be offered that with good contact between the concrete of a high dam and a reasonably hard and well-cemented sandstone or conglomerate there need be no apprehension that enough of the calcite binding material will be removed to weaken the rock appreciably.

Gypsum in some localities occurs as a cementing material in sandstone. A gypsiferous sandstone cannot be regarded as a safe foundation for a dam.

Softening in Water

Some clastic rocks, particularly those held together by films of clay, may be fairly hard when dry but become soft and plastic when wet. Probably the most tragic and impressive illustration of the importance of recognizing this property when present in the rocks of a dam site was furnished by the failure of the St. Francis dam, early in the present year. A simple immersion test would have revealed the utter unsuitability of the conglomerate under the northwest abutment for the foundation of a high dam. Other rocks, particularly some soft sandstones, show a decrease in strength when wet, although the change is not often so pronounced as in the conglomerate just described. It it the part of prudence to subject any clastic rock to an immersion test before accepting it as a safe foundation for a dam.

A fault is likely to continue to be a plane of weakness and may show recurrent movements separated by long periods of quiescence. For example, there is strong evidence for the conclusion that the great Verde fault in the Jerome district, Arizona, after a throw of 2,400 ft. in pre-Cambrian time, remained immobile throughout Paleozoic and Mesozoic time, but was active in late Tertiary or Quaternary time, with an additional throw of 1,600 ft., or a total of 4,000 ft. Renewal of movement, after long periods of rest, also took place in some faults in the Grand Canyon region of Arizona. In some faults the gouge has become lithified and is now a fairly hard rock. It appears safe to conclude that movement on such faults has not taken place for hundreds or thousands of years.

The mere presence of a fault does not justify the condemnation of a site. It is important, however, that its existence be known, that the probability of future movement be carefully considered and that the dam be designed to meet future contingencies, so far as this may be possible. Of course no dam should be built across a fault known to have been active in recent times.

Proximity to a known zone of active faulting does not necessarily imply serious danger to a high dam. Such dams are usually of concrete and are founded on solid rock. It is reassuring to remember that the Crystal Springs concrete dam, near San Mateo, Calif., was not injured by movement on the San Andreas fault in 1906, although the fault line passes only about 900 ft. west of the dam.

In considering the possible effect of an earthquake on a dam it is well to remember that a properly constructed high dam is built on solid rock and becomes in fact an integral part of the rock upon which it rests. Such a structure probably would be affected only by the short elastic waves that are propagated with high velocity through rock and not by the visible secondary waves that pass as terrifying and destructive undulations through alluvium or artificially filled ground. It is therefore, permissible in a region subject to earthquakes to examine the natural rock forms and to deduce from their condition the probable effect of future earthquakes on a concrete dam. This reasoning was recently applied to the proposed dam site at Angostura de Teras, Sonora, Mexico. This region experienced a severe earthquake in 1887, in which some lives were lost and damage was done to buildings in at least two small towns or villages.

In comparison with other regions of similar topography and climate, but not known to be subject to earthquakes, the rocks in the vicinity of Angostura de Teras are not exceptionally broken or shattered and the cliffs show no more than the normal quantity of rock débris at their bases. Particularly significant in such a comparison is the Angostura de Vallecitos, a very narrow gorge in rhyolite, a few kilometers east of the dam site. The walls of this gorge are practically vertical, in places overhang, and are at least 70 meters high. It would appear that any shock capable of destroying or seriously injuring a concrete dam would have shaken down these walls. An even more reassuring exhibit in the vicinity of the site is a slender residual spire of conglomerate, some 35 meters high, which obviously passed unscathed through the earthquake of 1887.

In a region where such relatively instable rock forms as those just cited have survived the only severe earthquake recorded in historical times, it is reasonable to conclude that a well-constructed concrete dam, founded on solid rock and situated in a canyon, would not be damaged by a future shock of equal intensity.

Dam sites which, from the geological point of view,

are ideal in all respects are exceedingly rare, if any exist. On the other hand it is perhaps a not unduly optimistic tribute to the skill of modern engineers to state that a dam may be built successfully on any site if the geological conditions are known and if no limit is placed on cost. In practice the construction of a dam involves compromise and adjustment between these two extremes. The one great point to be emphasized is that the engineers should have before them as complete and reliable a presentation of the geological conditions as it is possible to obtain. That 'esson no one who has seen the ruins of the St. Francis dam is ever likely to forget.

Four-Day Discussion of Municipal Work

A Summary of 30 Papers on City Planning and Administration, Water Supply, Sewerage, Refuse Collection, Street Paving, Lighting and Maintenance at the Convention of the American Society for Municipal Improvements

NOTABLE in choice, grouping on the program and high quality of subject matter and method of presentation were the 30-odd papers on the program of the 34th annual convention of the American Society for Municipal Improvements, held at Detroit, Mich., Oct. 22 to 26. The program covered nearly the whole field of the city engineer and the commissioner of public works and their bureaus, with a preponderance of papers on street pavements and maintenance. As a rule, there was a closely related group of papers for each session, ending in most cases with papers by representatives of manufacturers or contractors in the corresponding line. A summary of the papers follows.

City Planning and Government

Detroit has master plans for streets, water and sewers but no plan co-ordinating all the individual plans, said Walter H. Blucher, secretary, Detroit City Plan Commission, in a paper on "Carrying Out a Master Plan." The Detroit thoroughfares plan, combined with that of the Rapid Transit Commission, provides for major highways extending 15 miles beyond the city limits. In the execution of this combined plan the outlying municipalities are co-operating. One element at a time instead of attempting to carry out simultaneously all the parts of a master plan was advised by the speaker. At Kitchener, Ont., said S. Shupe, nothing has yet been done on that part of a city plan providing for extensive changes in the center of the city, submitted some years ago, but recently considerable work has been done in the outskirts of the city. Advisory service to cities by the Pennsylvania Bureau of Municipal Affairs was outlined in a paper by Francis J. Mulvihill, chief, division of city planning and municipal engineering.

Automobile Transportation in Michigan

In a paper on Automobile Transportation in Michigan, Frank H. Rogers, state highway commissioner, said that the increase by 175 times of motor vehicles in Michigan since 1908 by no means represents the increase in traffic, as gasoline consumption shows. Nor do the traffic counts bear out the contention of the cities that they ought not to contribute so heavily as they do to country highway construction. If it were not for the traffic from the cities there would be no paved highways outside them. As to criticism of gravel road construction, Mr. Rogers said that if concrete had been used instead of gravel only 55 instead of 92 per cent of the state highway system of Michigan would now be improved. The gravel roads are constantly being replaced by concrete. Michigan is now maintaining 7,406 miles of highway at a yearly cost of $5,290,000. Snow was removed last winter from 6,682 miles at an average cost of $83 per mile. The snowfall in 1927-28 was exceptionally high.

A paper on the "Relative Value of Pedestrian, Automobile and Street-Car Use of Public Streets," by S. R. De Boer, city plan engineer, Denver, Colo., dealt with studies and curb-to-curb street widening in Denver.

Airport Sites

A score system for use in choosing one of more than a hundred sites for a $2,000,000 county airport, used by Perry A. Fellows, city engineer, was outlined in a paper by him on "Selection and Development of Airport Sites." When the problem was taken up by Mr. Fellows the sites had been narrowed down to fifteen, with three designated as preferred. He scored six sites, taking into account twenty elements, such as drainage and fog. This method helped greatly in dealing with rival real estate claims. The selection of airport sites, Mr. Fellows said, offers a field for engineers, who should assert their claims to the work instead of leaving the matter to realtors. Maximum needs should be taken into account, but actual construction should be limited to immediate needs, in view of rapid changes in this field. In discussing the paper, T. C. Hatton, Milwaukee, indorsed the proposal to go slowly. He believed the time will come when instead of 1,500 ft. for landing 250 ft. will do, and it will not be necessary, as now, to have airplanes land 10 or 15 miles outside a city. A. H. Blanchard, Chicago, said that runways are but another form of highways necessitating a choice of material to meet airplane conditions. A governing question is the effect of different runway surfacing materials on the airplane tails, skidding and the like. Too soft material might foul a plane in a cross-wind, too smooth might cause skidding in icy weather.

A plea for local or municipal regulation of utilities, whether publicly or privately owned, was made by Gerald J. Walker, consulting electrical engineer, Grand Rapids, Mich. He urged that municipally owned utilities should charge rates to cover all capital and operating costs and earn 8 per cent on the investment. In Grand Rapids the water-works will soon be on a commercial utility basis except that no taxes will be paid by the municipally owned works. At the November election a vote will be taken on collecting a rental for the use of sewers.

Measurement of Municipal Government

To the end that the question of fair returns for the $11,000,000,000 of taxes paid yearly in the United States may be taken out of the realm of guesswork, Lent

D. Upson, director, Detroit Bureau of Governmental Research, made a plea for "Measurement of Municipal Government." Standards for the various classes of service and records of work done, its quantity and quality, are needed. Still another betterment plea, this one for adoption of uniform traffic regulations, was made by Arthur H. Blanchard, consulting engineer, Chicago. When Congress provides for a national highway system, as Mr. Blanchard predicted will soon be done, a nation-wide traffic regulation system will result, since states and cities must follow suit. Under the title "Latest Developments in Traffic Control," Joseph G. Regan, traffic signal specialist, General Electric Company, stated that an increasing number of cities are employing traffic engineers.

Water Supply, Sewerage and Refuse

The water-works system of Detroit, with its 250,000 service connections, was outlined by F. H. Stephenson, engineer of construction and maintenance. Steel is used for all mains more than 36 in. in diameter. Except under intricate conditions, all steel mains are laid by contract; all cast-iron mains are laid by day labor.

Digestion of Fine Screenings in Tanks

Of a half-dozen papers on sewage treatment, two dealt with the digestion of fine screenings in tanks: At Milwaukee, one summarizing tests on semi-working scale; the other describing the design of a small working plant of four units. The first of these papers was by Willem Rudolfs, chief of the sewage substation of the New Jersey Agricultural Experiment Station, at New Brunswick, who is also consultant to the Milwaukee Sewerage Commission. The semi-working scale tests were made in a tank, kept at a temperature of 80 deg. F., in which to seeded sludge 200 gal. of fine screenings was added, with subsequent additions from time to time. The tests ran for 290 days from June, 1927, of which 188 days were under working conditions. Except on Sundays, various analyses were made daily. Solids were reduced about 60 per cent. A 40-day digestion period was indicated, with a tank capacity of 1 gal. per capita, which might perhaps be reduced to 0.7 or even 0.6.

In the second of these papers Darwin W. Townsend, of the Milwaukee Sewerage Commission staff, described the design of a four-unit steel digestion tank, on the basis of a 30-day digestion period. Each unit is hopper bottomed and has a gas-collecting dome. The gas is used to heat water circulated in coils in the tank. City gas can be used if need be. Study of heat exchanges were made in design and will be continued in operation. The working-scale plant has been in use about a month, "tuning up."

In discussing these papers, H. P. Eddy, Boston, said that the tests thus far made at Milwaukee indicate that the biological process already in use for other elements in sewage treatment can be successfully applied to screenings, which, although small, are a troublesome part of sewage solids. Mr. Eddy urged a continuation of the sewage research carried on in this country for 40 years since its beginning at the Lawrence Experiment Station, Massachusetts.

Continued success with separate sludge digestion at Antigo, Wis., together with collection and use of the gas to heat the sludge, was reported by Jerry Donohue, consulting engineer, Sheboygan, Mich. The Antigo plant is at latitude 45 deg. N. The sewage passes through bar screens and grit channels to a one-story settling tank equipped with revolving sludge scrapers. The effluent goes to sprinkling filters, the digested sludge to drying beds. The gas produced in eighteen months totaled 2,300,000 cu.ft., equivalent to 100 tons of soft coal, which, delivered to the plant, would have cost $1,000 a year. The present sewage flow is 0.65 m.g.d., from 5,600 population.

A paper on aëration for the activated-sludge process was presented by George B. Gascoigne, Cleveland, Ohio. In America compressed air diffusion through porous plates is the process used except for some of the smaller plants. In England air and mechanical agitators, to take up air from the surface of the sewage, are about on a par, but air diffusion has been added to some of the surface agitation plants. For mechanical agitation in England sometimes paddle wheels and sometimes the "simplex" aërator is used; the latter is also used at several plants in America. A vertical steel tube is set in the center of the aëration tank. At the top of the tube is a revolving cone which draws mixed sewage and sludge up the tube and sprays it on the surface of the liquid of the tank. (See article by Mr. Gascoigne, *Engineering News-Record*, July 19, 1928, p. 91, "Sewage Treatment in the Light of European Practice.")

A paper on rebuilding a sewage-works at Manasquan, N. J., was submitted by L. L. Tribus, New York City, and one on sewage-settling tanks by M. B. Tark, of the Link-Belt Company. Collection of garbage with combustible refuse and disposal by incineration, and of ashes, cans, etc., separately, with the use of horse-drawn vehicles for house-to-house service and tractor-trailers for hauling, was advocated by Bruno C. Zinn, of the Highway Trailer Company, Milwaukee, who stated that in some 80 cities the introduction of trailers had materially reduced collection costs. Mr. Zinn advocated the keeping of collection records on a comparable basis. S. A. Greeley, Chicago, proposed tons as the unit for recording material collected, and said that besides length of haul there should be recorded number of houses served and the point from which the collector has to take the material.

Pipe for Sewerage Systems

In a paper on "Plain and Reinforced-Concrete Pipe in American Sewerage Systems," Asa E. Phillips, consulting engineer, Washington, D. C., said that replies from 300 questionnaires showed that about 25 per cent of the cities use plain concrete for smaller sewers; 25 per cent reinforced concrete for larger sizes; 25 per cent reinforced concrete for storm sewers; while 25 per cent use neither plain nor reinforced concrete. Among the cities using neither are Boston and St. Louis. W. W. Horner, St. Louis, said non-use at St. Louis was no reflection on concrete, but was due to the fact that three companies there make vitrified clay pipe and can supply it at favorable prices. T. C. Hatton, Milwaukee, said the use of concrete pipe by small cities was likely to be dangerous, because the engineers in such places are generally inexperienced in concrete work, have poor testing facilities and often have to rely upon unsatisfactory local producers of pipe.

Street Paving and Snow Removal

Two sessions, with a total of nine papers scheduled, were given up to paving and snow removal. A comprehensive national survey of specifications for concrete pavements, based on analysis of 125 sets of specifications, was presented by L. S. Trainor, manager, high-

ways and municipal bureau, Portland Cement Association, Chicago. He concluded that not more than three or four cities have first-class specifications, but thought half those examined show progressive trends.

A highly organized system of pavement design and supervision of construction at Pittsburgh, Pa., was outlined by Charles M. Reppert, chief engineer, department of public works, and Thomas M. Reed, chief engineer, bureau of engineering, in a paper on paving base construction. Notable reduction in percentage of material for aggregate rejected has been made by co-operative work at points of production. The standard base thickness is 6 in.; but up to 10 is used. Great pains are taken to obtain good drainage. From 1922 to date a 1:3:6 concrete has been used instead of the earlier 1:2:4. Its extra cost of 50c. a yard is thought to be fully justified. The poorest concrete of 1928 is better than the best of 1921.

C. D. Pollock, consulting engineer, New York City, praised the Pittsburgh methods in general, but believed the richer concrete will produce larger cracks than the poorer, and that these larger cracks will show at the surface. Agreement with this criticism was voiced by W. W. Horner, St. Louis, while George Warren, Boston, said too many thousand miles of 1:3:6 concrete pavement base is in use to warrant its condemnation. T. C. Hatton, Milwaukee, also spoke up for 1:3:9 concrete, especially under present improved methods. George F. Fisk, Buffalo, president of the A.S.M.I., said one part cement to eight of aggregates has been used with good results in Buffalo. To all these criticisms of the Pittsburgh mix Mr. Reppert replied that a good factor of safety is required on bridges; why not on concrete? He added that a crack once in 30 ft. is better than settlement and other defects.

Street Cleaning and Snow Removal

On the subject of street cleaning, A. P. Folwell, editor *Public Works,* New York City, summarized returns from 1,000 cities of less than 5,000 population. Of these, 20 per cent reported no street cleaning because of lack of pavements. The dominating method elsewhere was the use of hand brooms.

The advantages and methods of use of machines for snow removal were set forth in a paper by H. S. Greene, Barber-Greene Company, Aurora, Ill., first used in Chicago about 1920 and now employed in many cities. Figures for Boston, Mass., and Newark, N. J., on a cost-accounting basis that includes capital charges were cited to show the saving in snow removal by machine as compared with hand labor.

Asphalt Concrete Base

"Black Base" (asphalt concrete base) was the subject of a paper by Jacob Zuidima, city engineer, Holland, Mich., where the material has been used with satisfaction, he said. In a paper on "Granite as a Bridge Pavement," C. D. Pollock cited satisfactory experience in a number of cities, including blocks only 3½ in. thick on the Harvard bridge, Boston-Cambridge, Mass., which he said is in perfect condition after four years of use. Papers on "Use of Tar for Highways," by Walter Buehler, The Barrett Company, New York, and on "Asphalt Treatment for Low-Cost Highways," by William H. Rhodes, New Orleans Refining Company, indicated that for relatively small outlay old broken stone or gravel roads can be put in good usable condition. Another paper on rehabilitation of street surfaces described the use of surface heaters to restore asphalt pavements, either in patches, small or large, or for whole blocks. The author was R. A. MacGregor, engineer of maintenance, department of public works, Borough of Manhattan, New York City. In the past thirteen years nearly 1,000,000 sq.yd. of sheet asphalt in Manhattan, or nearly half of all in use, has been resurfaced in this way, using day labor. In Brooklyn borough like resurfacing is done by contract. Both renewal and original construction of brick pavements, urban and rural, were described by Fred E. Swineford, director of public works, Akron, Ohio.

Other Papers

Preceding the call for 25 committee reports at the closing session on Friday (see account of business proceedings of the conventions in the news pages of this issue) four papers were scheduled: "Prequalification of Bidders on Public Works," by William L. Collins, Hornell, N. Y.; "Tonight's Window Shopper Is Tomorrow's Customer," by L. A. S. Wood, manager street-lighting section, Westinghouse Electric & Manufacturing Company, South Bend, Ind.; "Are Engineers Clannish?" by Andrew Lenderink, consulting engineer, Kalamazoo, Mich.; and "Simplified Method of Cross-Sectioning Dirt Streets for Improvement," by W. R. Schreiner, Albany, N. Y. Mr. Schreiner did not appear. Mr. Collins outlined a plan, already coming into use, to limit bids on public works to contractors whose responsibility has been established. Mr. Lenderink's paper was a plea for engineers to do more to make themselves known and felt in their communities. Mr. Wood's paper was on street lighting, as was a paper presented earlier by D. M. Jones, street-lighting engineer of the Holophane Company, New York. Steel poles for street lighting, rolled and specially treated up to 60 ft. in length, was the subject of a lantern-slide talk by a representative of the Union Metal Manufacturing Company, Canton, Ohio.

Three Incinerators Being Added at New Orleans

A contract for three garbage and refuse incinerators was recently awarded by the city of New Orleans. Construction has begun on one and work will soon be started on the others, according to information from John Klorer, commissioner of public property. Two of the plants will be identical, with a capacity of 165 tons each in sixteen hours. The other plant will have a capacity of 50 tons in sixteen hours, but is so designed that an additional unit of the same capacity can be added later. All three plants will have furnaces of the Sterling type and the equipment for each will be installed by the C. O. Bartlett & Snow Company, Cleveland, Ohio. The buildings housing the three plants will be built by local contractors. At each of the new plants the bodies of the trailers in which the garbage is collected will be moved by overhead traveling cranes and their contents either dumped directly into the furnaces or stored in these bodies on the floor for later furnace charging. At none of the three new plants will an attempt be made to produce and utilize steam or to recover byproducts of any sort. For some time past the city has had in operation two incinerators of the Decarie type. At the larger of these, located near the business center of the city, the method of handling the garbage and refuse on its receipt is the same as proposed for the new incinerators as noted above.

Hours of Municipal Street Lighting

Governing Conditions on Which Judgments in Making Schedules Must Be Based—Artificial Light Necessary for Differing Periods Before Sunrise and After Sunset in Different Latitudes

By Edgar Dow Gilman
Director of Public Utilities, Cincinnati, Ohio

UNDER the leadership of C. O. Sherrill, city manager, Cincinnati is steadily improving those physical conditions which affect the daily lives of her citizens. One of the important factors of public convenience and public safety is that of the hours during which the street-lighting system is burning. Prior to 1926 the same schedule had been in use in Cincinnati for twenty years. In 1927 it was modified slightly as to the distribution of the annual hours, which were increased from 3,914 to 3,954, and the form of schedule was changed from weekly steps to daily variations. The opinion that further improvements could be made led to the study described herein.

This article presents some comparative facts and discusses some of the governing conditions on which judgments in making street-lighting schedules must be based. Actual times of lighting will depend largely upon varying opinions, and it is not the purpose here to attempt to say that any schedule is exactly right or wrong.

More will be said later about daily modifications of schedules because of weather conditions, but for purposes of comparison of what different cities are doing, the schedules are taken as they exist. In most cases they are based upon the assumption of clear weather, although in some cases modifications are made to take care of average seasonal conditions.

Standard clock times do not offer a basis of comparison of street-lighting schedules. Two cities at the same latitude and in the same time zone but at different longitudes have the same standard clock time, but the sun rises and sets later by such clock time in the western than in the eastern city. Therefore, to say that one city has better or worse street lighting in relation to its physical conditions of natural light because it turns its lights on earlier or later than the other city is not a correct statement. Cities of different latitudes will also have different times of sunrise and sunset as measured by standard clock time. But the difference in time of local sunrise or sunset is not the only factor that needs to be considered. Artificial light becomes necessary because natural light fails. The duration of time after sunset to that reduced intensity of natural light at which artificial light is necessary is different in different latitudes. Also, the duration of time before sunrise in the morning from the point at which artificial light ceases to be necessary is different at different latitudes. These durations of time may be called "twilight," referring either to the evening period or to the morning period.

The length of this twilight is variable. It is short in the southern cities and longer in the northern cities, because of the different angles which the plane of the sun's motion makes with the plane of the observer's horizon. Near the equator this angle is great, being approximately 90 deg., and the sun very rapidly gets that distance below the horizon at which its reflected rays cease to furnish adequate natural light. In more northern cities the angle of this plane is small, the distance that the sun must travel to arrive at the same vertical distance below the observer's horizon is greater, and a longer time elapses from sunset to an equal reduced intensity of natural light. It therefore is not a proper comparison, as between a southern and a northern city, to say that because the former turns its light on ten minutes after its sunset it has better street lighting than a more northern city which turns its lights on fifteen or twenty minutes after its local sunset.

It becomes necessary, in comparing the scheduled times of turning lights on in the evening or off in the morning, to convert such times to a common measure of light intensity—that is, eliminate the variables of time of sunrise and sunset due to differences of latitude and longitude, and the variable of length of twilight due to differences in latitude. With clear weather, and assuming a level horizon, the light intensities at different points on the earth's surface are practically the same when the sun is in the same position relative to horizons of the different points of observation. The basis of comparison should be taken as near as possible to that point of natural light intensity at which the best judgments would indicate the need of added artificial light in the evening or the cessation of that need in the morning.

In an article by H. H. Kimball, entitled "The Duration and Intensity of Twilight," published in the monthly *Weather Review* for November, 1916, U.S. Weather Bureau, two twilight limits are defined. One of these is called the "astronomical twilight," being defined as that point at which the last trace of any rays of the sun are visible except as reflected from other astral bodies. This occurs when the sun is 18 deg. below the observer's horizon. At this time the intensity of natural light has been reduced far beyond the point at which

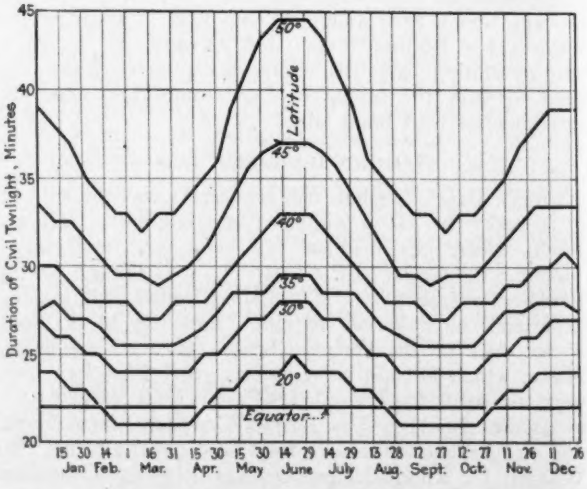


FIG. 1—VARIATION IN CIVIL TWILIGHT
Number of minutes after sunset or before sunrise that the sun is 6 deg. below the horizon at different latitudes.

artificial light is necessary and therefore is not a factor in this study.

"Civil twilight" is defined as follows: "We will therefore define the end of civil twilight in the evening and its beginning in the morning as the instant when the true position of the sun's center is 6 deg. below the horizon. At this time stars and planets of the first magnitude are just visible. In the evening the first purple light has just disappeared, and darkness compels the suspension of work in the open air unless artificial illumination is provided. In the morning the first purple light is beginning to appear, and the illumination is sufficient for the resumption of outdoor activities."

Other authorities quoted by Mr. Kimball define civil twilight as "the point when one can no longer read and write without artificial light." It "begins in the morning at the instant when we are first able to read ordinary printing with the back turned toward the east. It ends in the evening when we cease to be able to read with the back turned toward the sun's set."

With these definitions of civil twilight, it appears reasonable to take as a starting point for comparing the street-lighting schedules of different cities that instant at which the sun's center is 6 deg. below the horizon. How many minutes before or after this position of the sun are the street lights turned on in the evening or off in the morning? The standard clock time at which these positions of the sun occur night and morning for each city must first be computed.

The pamphlet entitled "Sunshine Tables," edition of 1905, published by the U.S. Weather Bureau, gives for each latitude the time of sunrise and sunset expressed in local mean sun time. With the latitude of a city known, the proper table can be consulted, and the hours of sunrise and sunset converted to standard time by adjusting the difference in longitude between the city and the 75th, 90th, 105th and 120th degrees for Eastern, Central, Mountain or Pacific time respectively.

Mr. Kimball's article gives for different latitudes the number of minutes after sunset or before sunrise that the sun is 6 deg. below the horizon. These are plotted in Fig. 1, and indicate a considerable variation not only with differences in latitude but also with seasons of the year. That this is an important factor to consider in comparing the street lighting of different cities is shown by the fact that there is nearly fifteen minutes difference in twilight between the southern and northern boundaries of the United States.

All results secured as above were tabulated for each city in the form shown by Table I for Cincinnati. Column 1 shows the date, columns 2 and 3 the local standard times of sunrise and sunset, respectively. Column 4 shows the duration of civil twilight. Column 5 is the local standard time of the end of evening civil twilight, secured by adding the minutes in column 4 to the time of sunset in column 3. Column 6 is the time of turning on the street lights as shown by the city schedule, and column 7 is the difference between columns 5 and 6 and shows the minutes before or after the end of evening civil twilight that the lights are turned on, being expressed as plus if they are turned on before and minus if after that time. Column 8 is the local standard time of the beginning of morning civil twilight, secured by subtracting the minutes in column 4 from the time of sunrise in column 2. Column 9 is the time of turning off the street lights as shown by the city schedule, and column 10 is the difference between columns 8 and 9 and shows the minutes before or after the beginning of morning civil twilight that the lights are turned off, being expressed as minus if before and plus if after that time.

While the light intensities of the different cities are practically the same at the instant of the end or the beginning of civil twilight, it must be realized that for any material variation in time from this instant they are no longer exactly equal. That is, there is a greater rate of change in light intensity in a southern city than in a northern city, and while the intensities are the same at the instant when the sun is the same distance below the horizon, if two cities of different latitudes each turn the street lights on ten minutes before or after such an instant, they are not doing so at points of equal intensity of light. This difference is probably theoretical for the short periods of time here involved, and the comparisons given are probably correct within practical limits.

Tables similar to Table I have been computed for Boston, Chicago, Cincinnati, Denver, Detroit, Louisville, Los Angeles, Minneapolis, Newark, New Orleans, Philadelphia, Pittsburgh and Seattle.

For purposes of graphical comparison of the results of these computations, Fig. 2 has been drawn in which the time of the sun at 6 deg. below the horizon is taken as zero and the minutes before and after this time of turning on and off the street lights are plotted.

A theoretical schedule based wholly on clear weather at all seasons would probably be represented by a straight vertical line, the distance from the zero line being governed by local opinions or by variations in the topog-

TABLE I—CINCINNATI, OHIO

Latitude 39 deg. 9 min.; longitude 84 deg. 37 min. Add 38 minutes to mean time for given latitude to reduce to Eastern Standard Time.

(1) Date	(2) Time of Sunrise, E.T.	(3) Time of Sunset, E.T.	(4) Length Civil Twil't, Min.	(5) End P.M. Civ. Tw., E.T.	(6) Lights Turned On, E.T.	(7) P.M. Variation, Min.	(8) Start A.M., Civ. Tw. E.T.	(9) Lights Turned Off, E.T.	(10) A.M. Variation, Min.
Jan. 1	7:58	5:26	29	5:55	5:35	+20	7:29	7:42	+13
7	7:58	5:32	29	6:01	5:41	+20	7:29	7:42	+13
15	7:56	5:40	29	6:09	5:49	+20	7:27	7:39	+12
22	7:52	5:47	28	6:15	5:56	+21	7:24	7:35	+11
Feb. 1	7:45	5:59	28	6:27	6:08	+19	7:17	7:26	+ 9
7	7:39	6:06	28	6:34	6:15	+19	7:11	7:19	+ 8
15	7:30	6:15	28	6:43	6:27	+16	7:02	7:07	+ 5
22	7:20	6:23	28	6:51	6:35	+16	6:52	6:55	+ 3
Mar. 1	7:11	6:30	28	6:58	6:44	+14	6:43	6:41	— 2
7	7:03	6:37	27	7:04	6:52	+12	6:35	6:30	— 5
15	6:49	6:45	27	7:12	7:02	+10	6:22	6:17	— 5
22	6:38	6:52	27	7:19	7:12	+ 7	6:11	6:03	— 8
April 1	6:22	7:01	28	7:29	7:24	+ 5	5:54	5:45	— 9
7	6:13	7:07	28	7:35	7:32	+ 3	5:45	5:35	—10
15	6:01	7:15	28	7:43	7:41	+ 2	5:33	5:22	—11
22	5:51	7:22	28	7:50	7:49	+ 1	5:23	5:10	—13
May 1	5:40	7:30	29	7:59	7:58	+ 1	5:11	4:56	—15
7	5:33	7:36	29	8:05	8:04	+ 1	5:04	4:46	—18
15	5:25	7:44	30	8:14	8:12	+ 2	4:55	4:37	—18
22	5:19	7:50	31	8:21	8:20	+ 1	4:48	4:29	—19
June 1	5:13	7:58	32	8:30	8:27	+ 3	4:41	4:22	—19
7	5:12	8:01	32	8:33	8:31	+ 2	4:40	4:19	—21
15	5:11	8:05	33	8:38	8:36	+ 2	4:38	4:17	—21
22	5:12	8:07	33	8:40	8:37	+ 3	4:39	4:16	—23
July 1	5:16	8:08	33	8:41	8:37	+ 4	4:43	4:18	—25
7	5:19	8:06	32	8:38	8:36	+ 2	4:47	4:21	—26
15	5:24	8:03	32	8:35	8:35	0	4:52	4:27	—25
22	5:30	7:59	31	8:30	8:32	— 2	4:59	4:34	—25
Aug. 1	5:38	7:50	30	8:20	8:23	— 3	5:08	4:44	—24
7	5:44	7:43	30	8:13	8:17	— 4	5:14	4:50	—24
15	5:51	7:34	29	8:03	8:06	— 3	5:22	4:58	—24
22	5:58	7:24	28	7:52	7:57	— 5	5:30	5:09	—21
Sept. 1	6:07	7:09	28	7:37	7:42	— 5	5:39	5:22	—17
7	6:12	7:00	28	7:28	7:33	— 5	5:44	5:30	—14
15	6:19	6:47	28	7:15	7:19	— 4	5:51	5:40	—11
22	6:26	6:36	27	7:03	7:07	— 4	5:59	5:49	—10
Oct. 1	6:34	6:21	27	6:48	6:52	— 4	6:07	6:01	— 6
7	6:40	6:12	27	6:39	6:41	— 2	6:13	6:10	— 3
15	6:48	6:00	28	6:28	6:28	0	6:20	6:20	0
22	6:55	5:50	28	6:18	6:15	+ 3	6:27	6:29	+ 2
Nov. 1	7:06	5:38	28	6:06	5:58	+ 8	6:38	6:42	+ 4
7	7:12	5:31	29	6:00	5:49	+11	6:43	6:49	+ 6
15	7:21	5:24	29	5:53	5:39	+14	6:52	7:00	+ 8
22	7:29	5:20	29	5:49	5:31	+18	7:00	7:09	+ 9
Dec. 1	7:38	5:16	30	5:46	5:26	+20	7:08	7:20	+12
7	7:44	5:16	30	5:46	5:25	+21	7:14	7:27	+13
15	7:50	5:17	30	5:47	5:25	+22	7:20	7:35	+15
22	7:54	5:19	31	5:50	5:27	+23	7:23	7:39	16

raphy from the level horizon assumed. When there are no methods of varying the schedule for daily weather conditions, and yet it is known that summer days are generally clear and winter days are more often cloudy, it is reasonable that the curve should be modified to take care of such conditions. The diagram for Cincinnati is an example of this situation, but experience has shown that too great modifications have been made.

The diagrams show the effect of the schedules of some cities being based on a fixed relation to the time of sunrise and sunset without regard to the seasonal variations in the length of civil twilight. This is shown, particularly in cities of northern latitudes, by variations in the diagrams similar to the curves of Fig. 1.

The study of these schedules has brought up some interesting questions. One is whether or not in these days of electric street lighting it is necessary to have a street-lighting schedule that changes in steps, or whether it is not better to have a schedule that changes day by day. By "steps" is meant a schedule at which the time of turning on and off the lights remains fixed for a number of days. Many of the cities here considered have such schedules, which accounts for the irregularity of the curves in Fig. 2. Previous to 1927 Cincinnati had such a schedule. This meant that on one night the street lights were turned on as much as fifteen minutes earlier than they were the night before. If artificial lighting was not needed for those fifteen minutes the night before, there is a waste of light on the following night; or if artificial light was needed for that time on the second day, then there was a deficiency of light the night before. In other words, such a stepped schedule does not provide the best distribution of the light which is being paid for. While such a form may have been necessary in the old lamplighted days, there appears no reason for adhering to such an arrangement today, when lights are turned on or off by throwing a switch at a switchboard where there are always attendants.

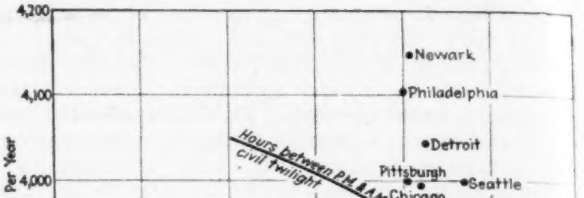


FIG. 3—VARIATION OF ANNUAL HOURS BETWEEN EVENING AND MORNING CIVIL TWILIGHT AND LATITUDE AS RELATED TO ACTUAL LIGHTING IN VARIOUS CITIES

Can street-lighting schedules be modified to meet daily weather conditions? The lights should be turned on earlier in the evening and off later in the morning if the day is dark and cloudy. Some cities have worked out this plan to some extent, but many have done noth-

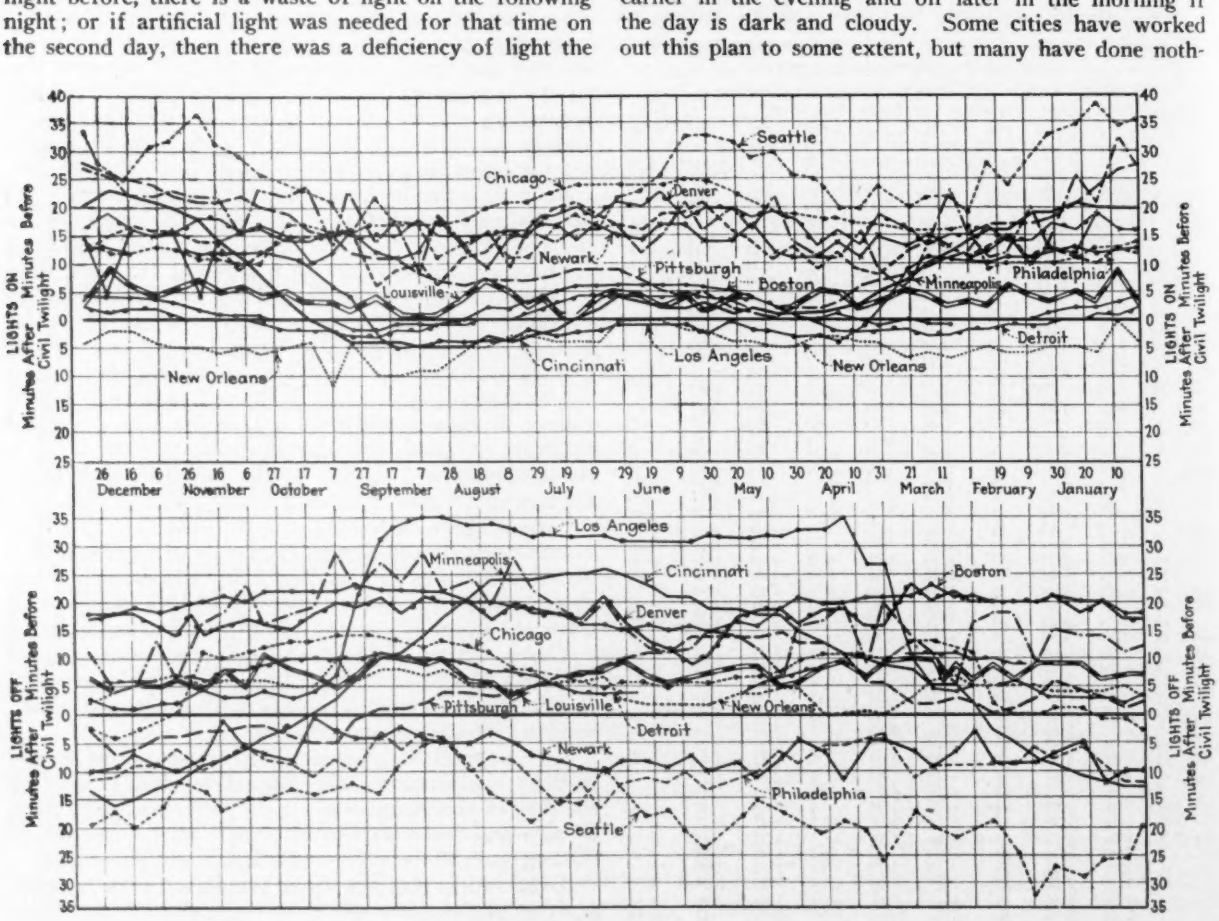


FIG. 2—MINUTES BEFORE AND AFTER EVENING AND MORNING CIVIL TWILIGHT THAT STREET LIGHTS ARE TURNED ON AND OFF IN VARIOUS CITIES

TABLE II—ACTUAL ANNUAL HOURS OF STREET LIGHTING IN VARIOUS CITIES

City	Lat., N., Deg.-Min.	Long., W., Deg.-Min.	Std. Time	Hours Light Per Year	Hours Per Year Between P.M. and A.M. Civ.Tw.	(5)—(6)
Boston	42-21	71-04	E.T.	3,828	3,935	—107
Chicago	41-53	87-37	C.T.	3,995	3,940	+ 55
Cincinnati	39-09	84-37	E.T.	3,954	3,958	— 4
Denver	39-45	105-00	M.T.	3,945	3,954	— 9
Detroit	42-20	83-03	E.T.	4,045	3,933	+112
Louisville	38-15	85-45	C.T.	3,944	3,964	— 20
Los Angeles	34-03	118-15	P.T.	3,902	3,987	— 85
Minneapolis	44-29	93-18	C.T.			
Residence				3,830	3,912	— 82
Business				3,921	3,912	+ 9
Newark	40-42	74-00	E.T.	4,149	3,945	+205
New Orleans	29-57	90-04	C.T.	3,953	4,009	— 56
Philadelphia	39-56	75-11	E.T.	4,104	3,952	+152
Pittsburgh	40-26	80-00	E.T.	4,000	3,947	+ 53
Seattle	47-37	122-20	P.T.	4,000	3,877	+123
Washington	38-54	77-03	E.T.	3,942	3,958	— 16

ing in this regard. Quotations from several cities indicate slight progress:

When weather conditions are bad the light company usually helps out.

Lamps are lighted according to schedule irrespective of weather.

In case of cloudy weather the lights are turned on ten or fifteen minutes earlier.

Street lights are not handled strictly by schedule, but are all turned on and off by the operators, who vary the schedule according to weather conditions.

On dark and cloudy days lights are lighted fifteen minutes earlier and extinguished fifteen minutes later than schedule time.

Light five minutes earlier if cloudy. Light ten minutes earlier if it rains. Light fifteen minutes earlier if it rains and is very cloudy. If very cloudy in morning operate lights from five to ten minutes longer.

During the war we could increase the hours of lighting on a stormy day by giving the company one hour's notice, and we paid a pro rata amount per lamp per hour.

The quotations given indicate that variations can be and are made in some cities to take care of weather conditions. The need for such an arrangement is obvious, and the difficulties appear to be in the form of contract, where to place the responsibility and how to get responsible orders to the switchboards.

The cost of additional hours of street lighting is an important subject. However, this cost is not in proportion to the basic cost. Original contract prices are based on several items, such as (1) interest, sinking fund and insurance on investment, unaffected by time; (2) interest, sinking fund and insurance on plant, partly affected by time; (3) maintenance, partly affected by time (the life of a lamp is proportional to time, but the cleaning, painting and replacing of poles, glassware, cable, etc., is not); and (4) energy charge, which is directly proportional to time. As an example, the basic contract for street lighting in Cincinnati was figured for 3,914 hours per year. Last year a supplemental contract was made, permitting an increase not to exceed 40 hours per year. The prices in the original contract divided by 3,914 are from four to six times as great for the different units as are the prices per hour in the supplemental contract. The amount involved for additional time is so small compared with the cost of other factors that it is false economy for the city not to have all the light that it really needs. The expenditure of about $700,000 for street lights was increased by about $1,000 by the supplemental contract. The present scheduled 3,954 hours per year is the minimum that this city at this latitude should have, and these hours could well be increased by added time on dark days with only an insignificant increase in cost.

Several cities light their business areas longer than their residence areas. This is done in Minneapolis, Detroit and Denver. Experience in Cincinnati shows the desirability of doing this. Even when a city is on fairly level ground, the business section is more closely built up, and with higher buildings. Added to this is the fact that the business areas of many cities are in the basin of the community area and have a horizon far from the level one assumed in the preparation of the diagrams accompanying this article.

Comparisons of the annual hours of lighting in different cities cannot be made directly, because the number of hours during which artificial light is necessary for the same standards will vary with cities in different latitudes. The number of hours per year between evening and morning civil twilight for varying latitudes can be taken as the basis of comparison. Fig. 3 shows a curve representing these total annual hours from 20 to 50 deg. of latitude. On the same diagram the cities are plotted to indicate their latitudes and their actual annual hours of street lighting. The distance from this curve to the point at which a city is plotted offers a basis of comparing the annual hours. The values are shown in Table II and are plotted relatively in Fig. 4. A considerable variation is shown—from Newark, which has over 200 hours more, to Boston which has over 100 hours less than the hours between evening and morning civil twilight. Whether a city should have more or less is wholly a matter of judgment which may be affected by peculiar local conditions. While Fig. 4 indicates a comparison, it is not the purpose here to indicate that any one city in relation to its particular needs has a poorer standard of lighting than any other.

As a result of these studies new schedules are being prepared for Cincinnati which will hold the times of turning on and off the lights closer to the end and beginning of the civil twilight period. The daily variation in schedule, rather than the stepped form, will be continued. Moves will be taken to modify existing contracts to permit of variation from the schedules on dark days and to light the business area for a greater number of hours than the residence area.

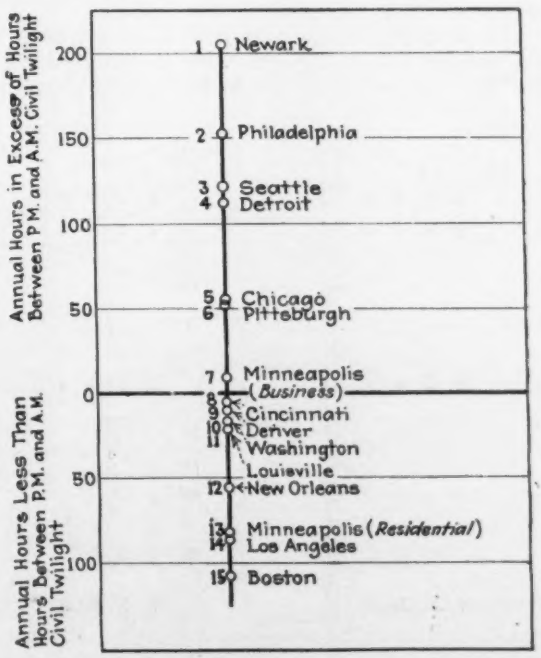


FIG. 4—RELATIVE LIGHTING OF CITIES IN RELATION TO THE HOURS PER YEAR BETWEEN EVENING AND MORNING CIVIL TWILIGHT AT GIVEN LATITUDE

Tests on Structural Details Flame-Cut From I-Beams

No Bad Results Shown From Flame-Cut Fabrication —Sequence of Punching and Cutting Immaterial

THE TESTS outlined in this article bear on a subject that is unusually alive in the New York City building field at the present time. Several failures of wind connections in structural steel frame buildings during erection have recently been attributed to flame-cutting fabrication of the details. The results of these tests by the Bureau of Standards strengthens the contention of many structural engineers that the cause of such failures as have occurred is other than the method of fabrication. —EDITOR.

ONE of the important details in the design and construction of tier building frames is the connection of the beams to the columns so that provision is made for the transmission of the local bending moments caused by wind pressure against the building. Such connections not only must be effective but should be made so as to allow a compact arrangement of the fireproofing. These requirements are satisfied by the detail shown in Fig. 1.

The wind connections at the top and bottom of the girder beam are made of pieces cut from I-beams rolled from steel made in accordance with A.S.T.M. specifications, serial designation A 7-24. It is generally believed that the only practical way of cutting these details from I-beams is by gas flame. Sawing or shearing would result in prohibitive cost. The usual practice is first to punch the beam in multiple and then to flame-cut the pieces from the long beams. Statements have been made that flame-cutting injures the material and that punching before cutting further increases the alleged damage, making the connections unreliable.

The American Bridge Company, to satisfy itself that the practice it had followed with no observed indications of developed weakness in the finished connections

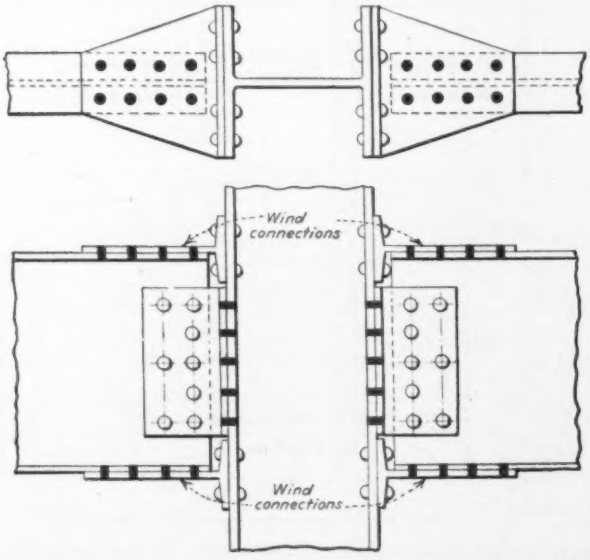


FIG. 1—BEAM-COLUMN WIND CONNECTION BY FLAME-CUT I-SECTIONS

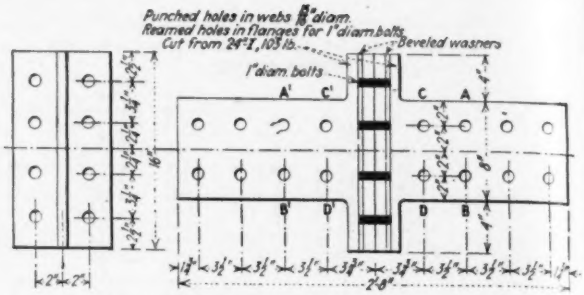


FIG. 2—ARRANGEMENT OF FLAME-CUT I-BEAMS FOR TENSION TEST

due to fabrication method was sound, made and had tested six sample connections. According to J. H. Edwards, chief engineer, American Bridge Company, who furnished the information in this article, these connections were exact duplicates of those being used in a 44-story building in New York City and were cut from a standard 24-in. 105-lb. I-beam. Three connections, designated in this text and the accompanying illustrations as No. 1, were made from one half of the beam in the usual way—punched and then flame-cut. Three connections from the other half of the beam were flame-cut and then punched, and are designated as No. 2. Tensile tests and impact and bending tests were made.

Tensile Tests—Two tensile tests were made by the

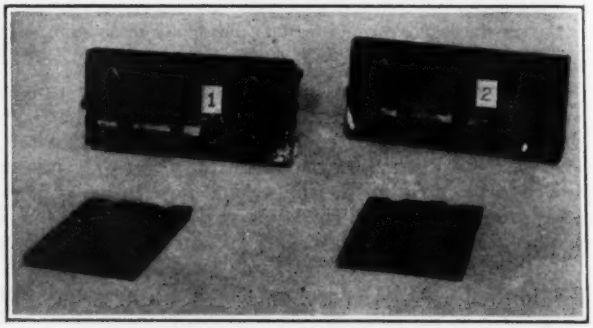


FIG. 3—FLAME-CUT I-BEAMS AFTER TENSION TEST Specimen No. 1, punched and then flame-cut. Specimen No. 2, flame-cut and then punched.

Bureau of Standards on a 600,000-lb. vertical testing machine. One flame-cut edge of each web had to be planed in order to be put in the machine. The results of the tensile tests are given in Table I.

The fracture of both specimens occurred through the punched holes on line *A B*, Fig. 2. The corresponding holes on line *A' B'* in the other web were elongated and on one specimen cracks were visible, starting from the edges of the punched holes. There was no indication that either method of fabrication was superior to the other. Fig. 3 shows these specimens after the tension test.

Impact and Bending Tests—Single pieces, marked

TABLE I—TENSILE TESTS ON FLAME CUT I-BEAMS

	Specimen No. 1	Specimen No. 2
Dimensions of tested section, in.	7¼x0.630	7¼x0.631
Gross area, sq.in.	4.96	4.97
Net area, assuming holes 1 in. in diam., sq.in.	3.70	3.71
Yield point, determined by drop of beam, lb.	158,000	160,000
Unit stress at yield point gross area, lb. per sq.in.	31,850	32,200
Unit stress at yield point net area, lb. per sq.in.	42,700	43,130
Location of fracture, Fig. 2	*AB*	*AB*
Area after fracture, sq.in.	3.22	3.23
Reduction in area, sq.in.	0.48	0.48
Reduction of area, per cent	12.98	12.94

TABLE II—IMPACT-BENDING TESTS ON FLAME-CUT I-BEAMS

Height of Drop, Ft.	Deflections of Web—Specimen No. 1, In.	Specimen No. 2, In.
1 to 4	No measurements	No measurements
5		No measurements
6		No measurements
7		No measurements
8		
10		
12	*	
15	††	
18	‡‡	‡

*Very small crack in punch burr. Die side convex.
†Cracks through punch burr. Die side convex.
‡No cracks. Punch side convex.

1 and 2, supported as shown in Fig. 4, were subjected to impact bending tests at the Bureau of Standards. A 50-lb. weight of nearly cubical form was dropped on

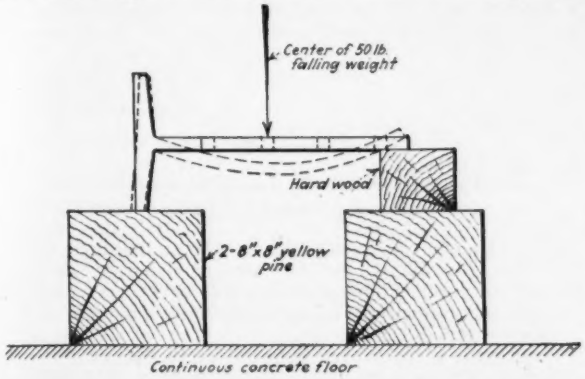


FIG. 4—ARRANGEMENT OF FLAME-CUT BEAMS FOR IMPACT-BENDING TEST

the web, beginning with a drop of 1 ft. and increasing by 1-ft. increments until a drop of 18 ft. was reached. The blows were directed so as to strike as nearly as possible the center of the web at the middle of the span. Deflections of the web on a 12-in. span were measured, and the results are summarized in Table II. Fig. 5 shows the specimens after the impact-heading tests.

Supplementary bending tests were made in a press at the Ambridge plant of American Bridge Company. The bending was continued until there was evidence of failure by cracks which developed in the edges of the punched holes. Fig. 7 shows a record of the failure and shape of the specimens after failure, while Fig. 6

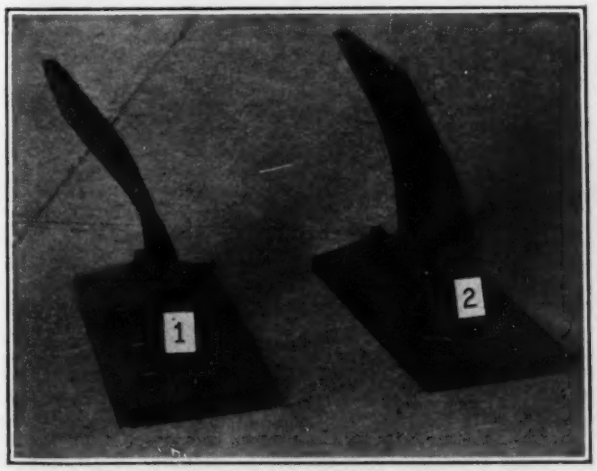


FIG. 5—FLAME-CUT I-BEAMS AFTER IMPACT-BENDING TEST
Specimen No. 1 punched and then flame-cut. Specimen No. 2, flame-cut and then punched.

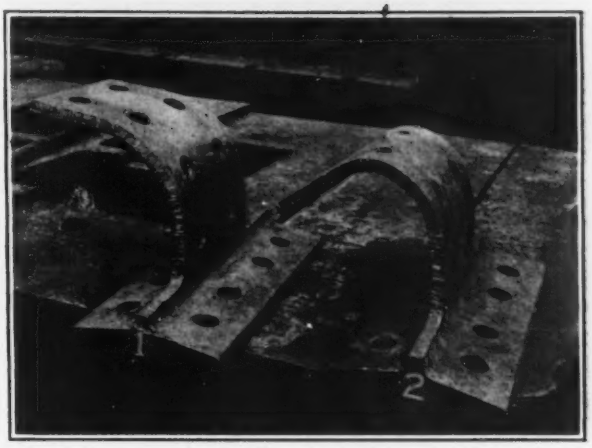


FIG. 6—FLAME-CUT I-BEAMS AFTER BENDING IN A PRESS

also shows their appearance after failure. The only crack at a flame-cut edge was on specimen No. 2, and it occurred through a center punch mark made when laying out the piece on the I-beam before it was cut. Specimen No. 1 had the die side of the punched holes and specimen No. 2 the punch side on the outside of the bend. All cracks appeared on the outside of the bent webs. Specimen No. 1 developed cracks when bent through a smaller angle than was required to crack

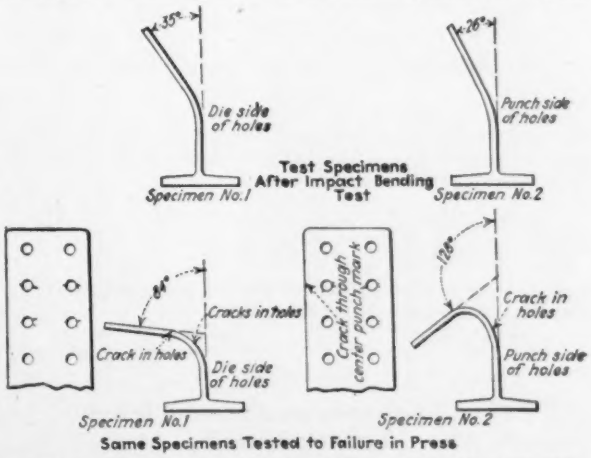


FIG. 7—RESULT OF BENDING TEST MADE IN A PRESS
Specimens after impact-bending test were further subjected to bending in a press.

specimen No. 2. This agrees with the results of many tests of steel bars punched and then bent.

There was no evidence from any of the tests that the fabrication by flame-cutting injured the material or that the sequence of punching and flame-cutting the specimens had any influence on the strength or reliability of the connections.

Paper Pulp Transported Through Pipe Line

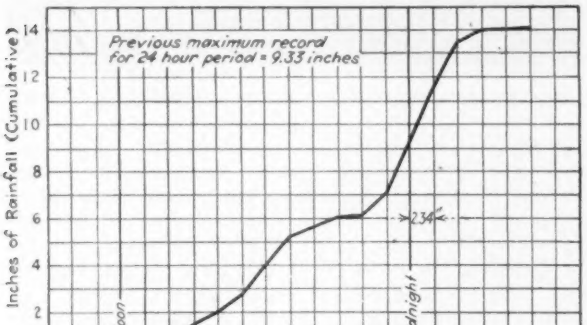
Ground paper pulp in flush form has been successfully transported 2 miles by means of a 10-in. line of cast-iron pipe at the mills of the Thunder Bay Paper Company, Current River, Ont. Recent tests of the line, which has just been completed, are declared by the company to be a complete success.

Letters to the Editor

Discussion by Readers of Various Matters That Interest Them

Another Instance of Heavy Rainfall

Sir—As there appears to be a reviving interest in the records of heavy rainfalls (see p. 330, issue of Aug. 30 and p. 482 of Sept. 27), the inclosed graph is submitted. This was made up from figures furnished by the local U. S.



CUMULATIVE RAIN GRAPH, NEW ORLEANS, LA., APRIL 15-16, 1927

Weather Bureau office and is the record of the shower which we had on April 15 and 16, 1927. From this graph it may be seen that we had the following:

Total for 24-hour period	14.01
Maximum for one-hour period	2.34
Maximum for twelve-hour period	12.7
Hourly rate for twelve hours	1.06

And, with the exception of the slight amount lost by evaporation, all that water was pumped off!

New Orleans, La., Oct. 9, 1928.

ARTHUR M. SHAW, Consulting Engineer.

Should Engineers on Appraisal Work Tell the Truth?

Sir—The article by Gregory M. Dexter, "Should Engineers on Appraisal Work Tell the Truth?" in the Sept. 20 issue of *Engineering News-Record* is timely and worthy of consideration and comment by the appraisal engineering profession.

I agree with Mr. Dexter that the differences in valuations made by appraisal engineers occurs so often as to discredit the work of the profession in the eyes of the layman as well as other practicing engineers. I, too, can relate instances similar to those mentioned by Mr. Dexter where the foremost appraisal concerns in the country have made fundamental errors in placing valuations upon properties. I believe, however, that the appraisal engineer is not to be blamed entirely for the present existing conditions under which he must labor. It is largely a lack of educational facilities which would properly prepare him for the work which he undertakes to do.

Appraisal engineering is one of the newer fields of engineering practice. It has been only ten or fifteen years since the matter of valuations has been given much consideration. The federal valuation of railroads and the federal income tax have proved great incentives to scientific valuation work. Several large national appraisal concerns have built up profitable businesses. To the engineer who seeks the technical knowledge that will fit him for valuation work all the doors of opportunity seem to be closed.

Information on valuation work used by the government, crude as some of it may be, is largely confidential and kept within the confines of the government archives. The big appraisal companies have no means of imparting their information except through training in the ranks. So far as the writer knows no technical school or university has developed an appraisal or valuation engineering course, and the information along these lines given in other engineering courses is insignificant.

Engineering practice today has been largely standardized through training in our technical schools, and I firmly believe that standardized ethical practice in appraisal and valuation engineering will come to pass only when technical schools provide the training and education which are necessary for the valuation engineer to carry on his work with a sense of security and approved public opinion and when a technical journal is established which will be given over exclusively to the dissemination of knowledge so essential to the successful conduct of an appraisal engineering business.

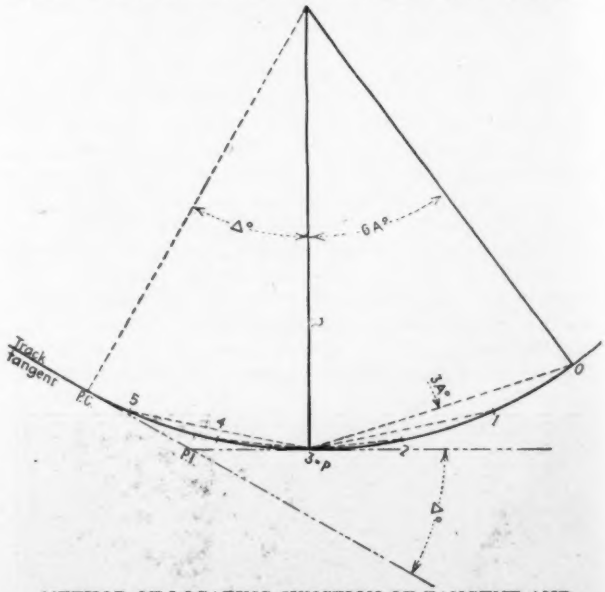
Denver, Colo., Sept. 26, 1928.

W. L. PROUTY, Appraisal Engineer.

Locating Junction of Tangent and Curve Lacking Original Data

Sir—The two solutions of this problem, published Aug. 9 and Sept. 27, fail to take into account the irregularity of old curved track. The method herewith shown combines the necessary track testing with the determination of the point of curve (*PC*).

From some point *P*, well onto the curve, set pins of each station as shown. With the transit at *P* read deflections



METHOD OF LOCATING JUNCTION OF TANGENT AND CURVE

from point 0 to points 1, 2, 4 and 5. If the angular differences are about uniform, the curve is regular and the average of the readings to point 5, multiplied by 3, will give the tangent direction at point 3. Set this angle, make the intersection at *PI* (point of intersection) and measure from *P* to *PI* the curve tangent, which distance also equals that from *PI* to *PC*.

Check by measuring the angle Δ, and computing the tangent with *R* equal to that of the degree of curve found by the average readings.

While this method requires more field work than those previously shown, there is nothing to compute. If a spiral is present, it will be detected, and enough data are at hand to compute the shift and approximate the spiral.

Detroit, Mich., Oct. 16, 1928.

P. R. VAN BUSKIRK, Civil Engineer.

News of the Week

Bridge and Building Association Holds 38th Convention in Boston

Committees Report Favorably on Precast Slab Construction and Jacking Methods for Placing Culverts

THE 38th annual convention of the American Railway Bridge and Building Association was held in Boston Oct. 23-25. Most of the program consisted of reports of committees, followed in all cases by lively discussions. Comparative methods of jacking and tunneling culverts under fills were reported by a committee and this report with subsequent discussion favored the jacking method from a cost standpoint and also in relation to traffic disturbance. Not only culverts but water pipes up to lengths of 600 ft. have been successfully jacked through fills and in some cases through natural ground, according to the discussions.

Other reports receiving much attention were those on precast slab bridge construction, the use of motor trucks in handling bridge and building supplies and the organization of means for handling emergencies in bridge and building work. Several railways favored the building of precast slab units with their own forces for the replacement of short span bridges. Motor trucks were favored for use in handling bridge and building supplies, especially around congested terminals where the use of work trains would seriously interfere with traffic. Motor trucks were also mentioned as playing an important part in emergency line repairs of several roads. The committee reporting on organization for handling emergency work stated that in most cases the existing maintenance and road organizations should be prepared to take care of any emergencies and that no special organization should be required.

The disastrous effects of the flood damage suffered by the New England railroads late last year was portrayed by illustrated talks given by representatives of the Boston & Maine and the Central Vermont railroads. The pictures showed not only the damage done to tracks and structures but also the reconstruction work necessary.

New Orleans was chosen for the meeting place next year. Officers elected at the convention are as follows: president, Maro Johnson, I. C. R.R., Chicago; vice-presidents, J. S. Huntoon, M. C. R.R., Detroit, C. S. Heritage, K. C. S. Ry., Kansas City, A. I. Gauthier, B. & M. R.R., Concord, N. H., H. I. Benjamin, So. Pac., San Francisco; secretary-treasurer, C. A. Lichty, C. & N. W. Ry., Chicago; asst. treasurer, F. E. Weise, C. M. & St. P. R.R., Chicago. Directors elected were: R. C. Henderson, B. & O.; T. H. Strate, C. M. & St. P.; J. S. Ekey, B. & L. E.; G. A. Rodman, N. Y., N. H. & H.; W. A. Batey, U. P. R.R. and F. W. Hillman, C. & N. W.

POMEROY BEND TOLL BRIDGE COMPLETED

A new toll bridge across the Ohio River connecting Pomeroy, Ohio, with Mason City, W. Va., will be formally dedicated Nov. 12. It consists of a 665-ft. main span, anchor arms of 260 ft. each and plate girder and I-beam spans giving a total length of steel structure of 1,847 ft. 9 in. There is a 20-ft. roadway of 7-in. reinforced concrete and a 5-ft. sidewalk. The structure, which cost approximately $1,000,000, is owned by the Pomeroy-Mason Bridge Company, Charleston, W. Va., a subsidiary of the Dravo Contracting Company, Pittsburgh, Pa., general contractor for the bridge. The Mount Vernon Bridge Company, Mount Vernon, Ohio, was sub-contractor on the superstructure. Clarence W. Hudson was consulting engineer.

Philadelphia Chosen for Next Convention at A.S.M.I. Meeting

Proposal for Local Chapters Sent to Ballot—Manufacturers Well Represented on Technical Program

PHILADELPHIA will be the next meeting place of the American Society for Municipal Improvements. The new president is John Klorer, formerly city engineer of New Orleans and now a member of the council-commission heading the department of public property of the association. Other officials elected at the 34th annual convention of the association, held at Detroit, Oct. 22-26, are: vice-presidents, Paul L. Brockway, city engineer, Wichita, Kan., John W. Reid, commissioner of public works, Detroit, and J. H. Neeson, chief, bureau of highways, Philadelphia; secretary, C. W. S. Sammelman, City Hall, St. Louis; treasurer, S. Cameron Corson, city engineer, Norristown, Pa.

Retiring President George F. Fisk, commissioner of public works, Buffalo, N. Y., said in his brief opening address that the recent decline in the membership of the association (from 614 to 593 in the past year, following an earlier decline) is due largely to competition from various other technical societies. The treasurer's report showed an increase in the balance of funds, compared with a year ago, and an investment of $1,500 in bonds.

Amendments of the constitution sent to letter ballot were chiefly minor, but included one authorizing the formation of local sections of the association by twenty or more members of all grades, with power to assess members not over $4 a year in addition to the association dues. Secretary Sammelman expressed the hope that active members, even in small places, would make themselves the nucleus of a local section composed largely of affiliate members.

Committee reports numbering some 25, including representatives on joint committees, were scheduled for the last session, but for the most part were of the "progress" variety and elicited no discussion. Proposed specifications for portland-cement concrete foundations were submitted by a committee headed by J. C. McVea, city engineer of Houston. This was printed in the September *Bulletin* of the association, together with some other committee reports.

A resolution against pavement contract guarantees for more than five years, submitted by Edwin A. Fisher, of Rochester, N. Y., was adopted, as an affirmation of earlier action by the Association for Standardizing Paving Speci-

fications, which was merged with the A.S.M.I. many years ago.

Papers presented during the convention, arranged by general topics, are summarized on p. 659 of this issue. A visit to the Detroit water-filtration plant and to the Ford airport and airplane plant occupied one afternoon. There was a small but well-arranged exhibit by manufacturers and dealers. Representatives of supply and contracting companies were given numerous places on the program, generally near the close of each session. The companies thus represented included the Highway Trailer, The Barrett Company, Warren Brothers, New Orleans Refining, Barber-Greene, Westinghouse Electric & Manufacturing, Holophane, and Union Metal Manufacturing (Canton, Ohio), the last three dealing with street lighting and electric light poles.

Deadwood Dam Approved

Official approval of the feasibility of the Deadwood dam and reservoir in Idaho by President Coolidge, on the recommendation of the Secretary of the Interior, was announced by the U. S. Department of the Interior on Oct. 20. This construction was authorized by Congress at its last session, but, under the reclamation law, before the work could proceed it was necessary for the Secretary of the Interior and the President to make a determination as to feasibility.

The project is located on the Deadwood River, a tributary of the Payette River, about 60 miles northeast of Boise, Idaho. The proposed dam will be of the arch type, 600 ft. long, with a maximum height of 160 ft., and will contain approximately 50,000 cu.yd. of concrete. It will cost about $1,200,000, of which $800,000 has already been appropriated. The reservoir created will have a capacity of 160,000 acre-ft. A diversion dam and power plant have already been constructed on this project at a cost of $1,949,000, but to attain maximum return from and proper utilization of the investment additional storage must be provided. It is estimated that the receipts from the sale of power generated under the project will be ample to return the entire cost of construction of the reservoir within 40 years.

Chicago to Vote Again on $26,491,000 Bond Issues

The Chicago city council has approved ordinances which will submit to the voters of the city for the second time on Nov. 6 twelve proposed bond issues totaling $26,491,000. Of this amount $1,500,000 is for street lighting and $450,000 for improvements to the Cicero Ave. airport, the remainder being for various unfinished street improvement projects throughout the city. Practically the same program was submitted at the primary election last April and was beaten by a 2 to 1 majority.

William Henry Crocker Dies

William Henry Crocker, editor of *The American Architect*, died in Orlando, Fla., Oct. 22, as the result of injuries sustained in an automobile accident. He was 71 years of age. Born in New York City, Mr. Crocker entered the College of the City of New York, but before finishing his course entered the United States Navy as a midshipman. During his naval career he rounded Cape Horn three times and circled the globe twice, until he was forced to retire from the service, by the loss of his hearing, caused by the explosion of a cannon while a salute was being fired in China. Returning to civil life, he became an accountant with the Phelps Dodge Company, and later with the Seth Thomas Clock Company. His connection with *The American Architect* began in 1905 as a professional photographer. In 1910 he was appointed associate editor and seven years later editor-in-chief, which position he held until the time of his death. He was an honorary associate member of the New York Chapter of the American Institute of Architects.

Wm. H. Crocker

Moffat Bonds Held Valid

The suit brought by certain taxpayers of Denver to determine the status of bonds issued by the Moffat Tunnel Commission in excess of the authorized amount of $6,720,000 has been closed, the court deciding that all bonds issued are valid. The law creating the tunnel commission directed it "to build a tunnel" and delegated to the board "all powers necessary and requisite" for that purpose. It was held that these provisions gave the board authority to borrow sufficient money to complete the tunnel, despite an additional provision in the original law which authorized it "to issue the negotiable bonds of said district in an amount not exceeding $6,720,000." This amount was determined by the original cost estimate. The final cost of the completed tunnel, according to figures lately made public, was $17,813,972.89. Of this amount, the main items of expense were:

Labor, supplies, and expenses of tunnel construction	$9,550,480.34
Administration	403,378.41
Engineering	476,415.29
Camp	631,585.39
Plant	1,046,218.92
Boarding houses	867,977.08
Commissary	422,088.94
Insurance	384,092.95
Contractor's fee	140,000.00
Ventilation plant	254,139.89
Bond interest	2,960,975.00

Outstanding bonds total $15,470,000 only, the rest of the money expended having been obtained from interest payments, commissary and boarding houses, salvage on plant and similar sources.

Brief News

WITH ONLY 11 IN. OF CLEAR WATER under her keel, the steamship "Edward Luckenbach," with an estimated displacement of between 18,000 and 20,000 tons, was recently locked through the New Orleans industrial canal, between the Mississippi River and Lake Pontchartrain.

THE MOFFAT TUNNEL COMMISSION has withdrawn its suit against the Denver & Salt Lake Railroad for the collection of $130,137.95 unpaid rental. It is stated that the case will be settled out of court.

A MODEL CITY is to be constructed in the vicinity of Calhoun Falls, S. C., according to plans made public by a corporation headed by S. S. McClure, publisher, which has been formed to put the plan into effect.

CONSTRUCTION OF A 25-STORY BUILDING in the city of Bello Horizonte, Brazil, will start soon, according to plans recently announced. This will be the tallest building in Brazil, a 22-story building in Sao Paulo holding the record at present.

ELECTRIC CAR RETARDERS are being installed by the New York Central Railroad in its freight yards at Rotnour Bridge, near Syracuse, N. Y.

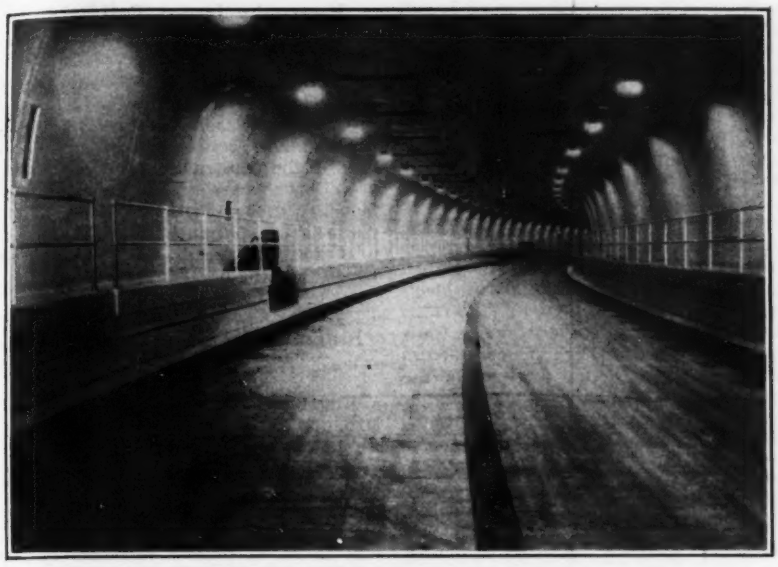
ELECTRIC OPERATION of the Boston, Revere Beach & Lynn Railroad has begun. The work of electrifying the system was completed in about six months time.

OPENING OF THE SIXTH ST. BRIDGE in Pittsburgh, Pa., marks the completion of the third of a series of three bridges built to identical plans and dimensions. All three structures are of the suspension type and cross the Allegheny River. The Seventh St. bridge was opened in 1926 and the Ninth St. bridge in 1927. All three were formally dedicated Oct. 19.

A SURVEY OF THE TIDES and currents of Chesapeake Bay has just been completed by the government in the interests of navigation and local engineers dealing with sewage disposal and tidewater construction problems. Data obtained will be published soon in a report.

PRELIMINARY SURVEYS for the St. Lawrence River international bridge, west of Brockville, Ont., have been completed. The bridge was authorized at the last session of Parliament. It is planned to make use of Smiths and Refugee islands as stepping stones for the crossing of the river, which is approximately 1 mile in width at that point.

A NEW $1,000,000 SUSPENSION BRIDGE across the Ohio River at St. Marys, W. Va., was dedicated Oct. 25. The structure is 1,952 ft. long and 102 ft. clear above low-water mark.



OAKLAND ESTUARY TUBE OPENED TO TRAFFIC

Interior view of the completed vehicular subway under the estuary between Oakland and Alameda, Calif., recently named the George A. Posey tube, which was opened to traffic on Oct. 27. This tube, the design and construction of which were described in *Engineering News-Record*, Oct. 28, 1926, p. 692; March 10, 1927, p. 392; and Jan. 19, 1928, p. 100, is 4,436 ft. long and has a roadway 24 ft. wide. It was built in dry dock in 203-ft. precast sections which were floated to place, sunk and connected under water in depths up to 90 ft. The joints between adjoining sections of the tube are said to be remarkably free from leakage.

N. Y. Subway Contracts Awarded

Since our last notation in the issue of Oct. 18, 1928, p. 601, the New York City Board of Transportation has awarded two additional contracts for subway extensions. In the Borough of Queens, a section known as the Steinway loop, under parts of Northern Boulevard, Steinway Ave. and Broadway, was awarded to the John F. Cogan Company, low bidder, for $8,244,267. In the Bronx, the third section of the Bronx Concourse route from 167th to 175th St. was awarded to the Clemente Contracting Company for $4,813,100.

American Engineer Appointed to Assuan Dam Board

Hugh L. Cooper, of New York City, has been named a member of an international commission of three appointed by the Egyptian government to consider the feasibility of raising the Assuan dam on the Nile. A number of proposed plans for this purpose have already been submitted to the government, and it will be the task of the committee to decide whether further heightening of the dam is feasible and, if so, whether any of the projects already submitted are suitable. If not, the commission will plan its own method.

The commission will also consider the possibility of utilizing the water power of the Nile for the generation of electricity and the effect which this scheme will have upon the effort to create a bigger reserve of water for the dry months.

A.E.C. Report on Street Signs, Signals and Markings Ready

Results of the comprehensive survey of street traffic signs, signals and markings undertaken as the contribution by the American Engineering Council to the work of the National Conference on Street and Highway Safety have now been put in type and will soon be available. The closest contact and the fullest co-operation have been maintained with, and the A.E.C. committee made a part of, the committee of the National Conference organized to draft a model municipal traffic ordinance.

The object of the survey was to determine the best practice in all cities having a population of 50,000 or more and some under that figure, then to formulate recommendations for the establishment of better and more uniform practice as a means of increasing safety and facilitating traffic on city streets. This is similar work to the survey and production of the standard highway code by the joint board on interstate highways of the Bureau of Public Roads and the American Association of State Highway Officials, a code now generally adopted by the states.

Surveys by means of local committees of the A.E.C. and by elaborate questionnaires were made in more than 100 cities in 35 states, the cities having an aggregate population of more than 33,000,000. The committee's recommendations have been approved by the A.E.C. and by the American Engineering Standards Committee as a tentative American standard. It is the hope of the A.E.C. that cities will rapidly adopt this standard code, which contains 83 recommendations.

Some differences from the highway code are noted. For instance, signs are generally smaller, because vehicles move slower in cities. Colors for stop signs have a yellow background with red for the word "stop" in conformity with the generally recognized meaning of that color in traffic control devices. Black as used on highway signs cannot be made luminous. Red letters on yellow background avoid the use of white letters on a red background as recommended by the traffic signal color code committee in which the red background is not clearly visible at night and the letters if illuminated appear white.

A timely warning is sounded in a section on general counsel calling attention to the evil effects of placing control devices without adequate initial study by competent technical advice, resulting in fundamental errors such as installations where not justified at all or correcting one intersection at the expense of another intersection.

Southwest Water-Works Men Meet at Dallas

Consideration of sewage problems for the first time in its history was a feature of the annual convention of the Southwest Water Works Association which was held in Dallas, Tex., Oct. 15-18, with an attendance of approximately 400. W. T. Mayo, Shreveport, La., was re-elected president for a second term. Max M. Fife, Blackwell, Okla., was named vice-president, and Lewis A. Quigley, Fort Worth, Tex., secretary. The city of Tulsa, Okla., was chosen as the meeting place for 1929.

One subject arousing considerable attention was the sanitary protection of watersheds. Local health authorities seemed to favor entire elimination of all unnecessary sanitary burdens, while water-works officials seemed inclined to allow limited privileges, such as boating, fishing and hunting, under proper safeguards. A paper by L. A. Quigley stressed the vital importance of accounting for all water waste and leakages. Increasing activity in providing adequate water supply for Central and South America was forecast by W. F. Holloway, recently associated with the water supply of Santiago, Cuba.

At the first meeting of a sewage section ever conducted by the association, a paper on the development of sewage-disposal plants in Texas was presented by V. M. Ehlers, chief state sanitary engineer of Texas. Mr. Ehlers' paper declared that although Texas had progressed remarkably in this field, the work had only been started. Marvin Nichols, of Fort Worth, discussed the sewage-disposal plant of that city, while operation at the Waco plant was discussed by Clyde C. Hays, and that at the Houston plant by Jack Fugate. Degasification was treated in a paper by J. Edgar Whedbee.

Legislation on Control of Dams Studied in California

State legislation to prescribe a more comprehensive and definite plan for supervising the construction and maintenance of dams is being studied in California by a committee composed of representatives of the four sections of the American Society of Civil Engineers in that state. This committee is working directly along the lines suggested editorially in *Engineering News-Record*, June 7, 1928, p. 880.

In a progress report a member of the committee announced that at a recent meeting in San Diego with all four members present there was unanimous agreement as to the basic principles involved, plans were laid for the effective functioning of the committee and decision was made to co-operate with other agencies that are working toward the same end.

It was agreed that there should be no exceptions to the rule that all dams should be under supervision of the state engineer both in construction and in maintenance. The attention of the committee is now being directed toward ascertaining the best form of organization for securing through that agency the desired control and supervision.

The personnel of the committee is as follows: Sacramento Section, George G. Pollock; San Francisco Section, Walter L. Huber; Los Angeles Section, F. D. Howell; San Diego Section, H. N. Savage.

Improved Building Inspection for San Francisco

The recent appointment of John B. Leonard as superintendent of the bureau of building inspection, San Francisco department of public works, marks a victory in the long struggle in that city to improve building conditions. Early in 1925 the San Francisco section of the American Society of Civil Engineers appointed a committee to endeavor to improve the situation and appropriated $500 for the use of the committee. Although this fund was not used, it proved the sincerity of the move and added force to the committee's action. Mr. Leonard has been chairman of this committee from the start.

Another important factor in the endeavor for improvement was the appointment of an advisory board for the bureau of building inspection, consisting of three members, an architect, an engineer and a general contractor. These three were selected, respectively, by local sections of the American Institute of Architects, the American Society of Civil Engineers and the Associated General Contractors. Each of these organizations also had committees which joined with Mr. Leonard's committee working for the desired result.

Coincident with this work the preparation of a uniform state building code was undertaken by committees from technical and contracting organizations from both the northern and southern sections of the state. This work is still under way, and upon completion of the code it is expected that it will be adopted in San Francisco. The Pacific Coast Building Officials' Conference has recently joined in the preparation of the uniform building code, so that organizations throughout the state are now in accord in this move.

Mr. Leonard has had wide experience in the construction field. His professional work has extended over some 35 years; in the first ten years he gained experience in shop practices with steel-fabricating firms, worked in the bridge department of the Southern Pacific Railroad and was employed by contractors in general construction work. For the last 25 years he has been a consulting structural engineer in San Francisco, devoting attention particularly to bridges and buildings. He was appointed superintendent of the bureau of building inspection after receiving the highest rating of those who took the civil service examination for the position.

Reforestation Recommended as Flood-Control Measure

The results of a special study of the effect of forests upon flood control in the Mississippi Valley have been published by the U. S. Forest Service in a report to be presented to Congress in December. The study was conducted in compliance with the flood-control act of 1928. Reforestation is not urged as an alternative to engineering work but rather as a supplementary step of such importance that no complete plan of flood control can omit it.

Kentucky Issues Toll-Bridge Bonds

The State Highway Commission of Kentucky has asked for bids on approximately $25,000,000 in toll-bridge bonds, the proceeds from which will be used in the construction and acquisition of toll bridges throughout the state. The bids are to be opened Nov. 28. It is planned to continue the collection of tolls until the bonds are redeemed, at which time the bridges will become free.

Indianapolis Annexation Starts Zoning Suit

Announcement of plans for the construction of a large coal plant on the Monon Railroad, just north of the city of Indianapolis, Ind., caused the city council, on Oct. 15, to pass an ordinance annexing that section to the city, placing it in a residential zone. This action was taken to protect residents of the locality. As the contractor announced his intention of proceeding with the plan, the city, on the day following the passage of the ordinance, entered suit to force the coal company to comply with the zoning restrictions. Two questions must be settled by the court: First, whether the signature of the Mayor makes the statute effective immediately, in view of the fact that the city charter specifies a period of ten days within which the Mayor is to consider the ordinance; and second, whether work started under one classification outside the city limits can be automatically stopped by annexing the territory and rezoning it.

RIVER SHANNON DAM NEARING COMPLETION

Wide World Photo.

Construction work on the Irish Free State hydro-electric project on the River Shannon near Limerick, Ireland, is in its final stages and generation of current is expected to begin in the near future. A portion of the massive concrete dam is shown in the illustration. The project, which was fully described in *Engineering News-Record*, April 7, 1927, pp. 554-557, involves more than 11,000,000 cu.yd. of earth and rock excavation and the placing of approximately 220,000 cu.yd. of concrete. The preliminary development will have a generating capacity of 90,000 hp.

Detroit Voters to Pass on $20,000,000 Bond Issue

At the general election, Nov. 6, the voters of Wayne County, Michigan, will be asked to approve a bond issue of $20,000,000 for the purpose of erecting a joint city and county building at the foot of Woodward Ave., Detroit. The structure will form a part of Detroit's proposed civic center. Plans for the building are now being prepared.

Large Greek Contract Awarded to American Company

The Greek government has awarded a contract entailing approximately $30,000,000 jointly to two American firms, Ulen & Company and John Monks & Sons, both of New York City. The work involves the construction of irrigation and drainage works in the Struma Valley, north of Saloniki and west of Philippi, in Greece, and also for the drainage of the marshes of Philippi and ancient Thessaly, farther west. It is stated that negotiations for the financing of the contract are being conducted with American interests.

Northwest Water-Works Men to Meet

The Pacific Northwest section, American Water Works Association, will hold its fall meeting at Seattle, Wash., Nov. 16-17. Among the papers scheduled to be presented are the following: "Water Resources of the State of Washington," by R. K. Tiffany, state supervisor of hydraulics, Washington; "Chlorination of Water Supplies in the Pacific Northwest," by H. W. Nightengale, sanitary engineer, Washington State Department of Health; "Underground Water Resources in the Vicinity of Tacoma," by Homer O. Blair, consulting engineer, Tacoma, Wash.; and "Design and Construction of a 3,000,000-Gal. Covered Concrete Reservoir," by C. A. McClain, general superintendent, Eugene, Ore., water board. The members will also make an inspection trip of portions of the Seattle water-supply system.

Another County in Chicago Region to Vote Bonds

Through the co-operative effort of the Chicago Regional Planning Association with the officials of Will County (adjacent to and southwest of Cook County) a definite road system has been laid out to fit that of contiguous counties. A bond issue of $1,750,000 of twenty-year serial 4¼ per cent bonds to pave 58.2 miles of the 154-mile system is to be voted upon Nov. 6. The major mileage, that around Joliet and the northern half of the county, connecting with the heavy-traffic roads leading out of Chicago, will be 20 ft. wide. The remainder will be 18 ft. wide. A tentative bid of $1,826,000 has already been received for the bonds.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

To Compile Mississippi Map Data—Propose Federal Aid for Airports—Waterways Rates

PRELIMINARY plans for mapping the Mississippi Valley have recently been announced by the War Department. This is the largest work of its kind ever undertaken by the government. It is expected that the survey will form an integral part of the topographic map of the United States, bringing this important system so much nearer to completion. The entire 30,000 square miles of area will be covered by standard 15 min. quadrangles with full topography on sea level datum. Quadrangle sheets will be published on the usual scale of 1 to 62,500, although supplemental maps on a larger scale will be made up where fine detail is required. On this plan the maps will serve not only for flood-control purposes but will be applicable to any type of engineering project.

In order to make use of all existing data, the Chief of Engineers has directed his district offices to co-ordinate the great mass of material in their possession. This includes a narrow strip map following the river which is considered excellent and can easily be brought up to date by revisions of culture and topography in areas subject to overflow erosion. There are also local maps, cross-sections and miscellaneous data compiled by various agencies. An old line of first order levels extends from Royalton, Minn., down almost to Baton Rouge. Some of the benchmarks have been obliterated and will have to be replaced. Otherwise the basic vertical control is complete except for such spur lines as may be necessary. There is an abundance of secondary elevations; others could be run from the first order benchmarks.

The horizontal control is not so complete. A system of third order triangulation parallels the river. This will be invaluable for the detailed surveying and mapping, but if the possibility of gaps and offsets is to be entirely eliminated, first order work will be essential. It would be possible to tie into the existing network and establish a system of steel triangulation towers from Cairo to the Gulf in about five months.

The Corps of Engineers, although hampered by a rush of problems all of which require quick action, is working to assemble all available mapping data as rapidly as possible under the circumstances. When this information is fully compiled, field work can be undertaken according to its urgency and in consideration of its relation to the whole project. In order to free army personnel from the highly specialized details of mapping and to permit their employment on the actual construction in the flood relief program, the mapping will be delegated to the U. S. Geological Survey and the Coast and Geodetic Survey wherever practicable.

Land Damage Payments

Announcement has been made by the Chief of Engineers that no payments will be made for flowage rights in connection with the flood-control program on the Mississippi until formal assurance has been given by the legal officer of the government that the land in the floodways is not to be considered the natural bed of streams. As a result interests in the Mississippi Valley are planning to hold a general conference in Memphis in the near future to consider what amendments, if any, to the flood-control act may be necessary to require such payments. The Chief of Engineers also has announced that flood-control works are being planned with a view to the extension of protection to much larger areas if the development of the country, during the period of construction, should justify such a change in the plans.

Government Airport Aid

Federal aid for airports will be proposed in a bill to be introduced by Representative Wilson, of Louisiana, on the convening of Congress. He argues that the reasons which prompted Congress in extending aid for highway construction apply with equal force in assisting the development of the navigation of the air. Representative Wilson also favors the development of a special meteorological service for airships in the Department of Commerce, where it could be co-ordinated with other civil and aeronautical activities.

Barge Line Joint Rates

In determining its procedure under the barge line act the Interstate Commerce Commission has been called upon, in the opinion of traffic specialists, to rule on a matter of far-reaching consequence to the railroads, as well as to present and future carriers on the inland waterways. The barge line act provides for the establishment of through routes and joint rates by the commission, without the delay of formal hearings, but providing that objections to the rates established are to be considered subsequently. The railroads contend that it would be unconstitutional for the commission, without a hearing and without a thorough knowledge of the facts, to establish arbitrarily through routes and rates over a wide area of the country, some of which are certain to be unreasonable.

The Judge Advocate General of the army, in his capacity as general counsel for the Inland Waterways Corporation, just has filed his brief with the commission, asserting that the commission should proceed immediately to the issuance of the certificate of convenience and necessity and should direct the establishment of through routes and joint rates with the barge line without first holding formal hearings.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Springfield, Ill.; annual meeting, Chicago, Ill., Nov. 12-15.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York, N. Y.; annual convention, Biloxi-Gulfport, Miss., Nov. 13-17.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; annual meeting, New York, N. Y., Jan. 16-18.

THE WISCONSIN SECTION, American Water Works Association, held its annual meeting Oct. 11-12 at Menasha, Wis. New officers of the section were chosen as follows: P. J. Hurtgen, Kenosha, chairman; H. W. Jackson, Antigo, vice-chairman; George A. Corine, Superior, director; and L. A. Smith, Madison, secretary-treasurer. The meeting next year will be held at Kenosha, Wis. Two of the questions before the meeting which are just beginning to be recognized by water-works men and were discussed in detail were the problem of selling the water-works to the public and also the problem of how to take care of water-works employees whose period of usefulness has ended. Other questions which received attention were proper filter plant operation, maintenance of meters and deep-well pumping.

THE MONTREAL BRANCH, Engineering Institute of Canada, will meet on Nov. 22 to hear an address on "Engineering Finance" by John H. Williams.

THE NATIONAL HIGHWAY TRAFFIC ASSOCIATION will hold its annual meeting Dec. 10-12, at New York City. A meeting of the South Central Division of the association is scheduled for Dec. 3 at New Orleans, La., and the North Central Division is to meet at Cleveland, Ohio, Jan. 16.

THE NORTH CAROLINA SECTION, American Water Works Association, will hold its annual convention Nov. 19-21 at Raleigh, N. C. At this meeting, the North Carolina Sewage Works Association will be organized. H. G. Baity, Chapel Hill, N. C., is secretary.

THE MILWAUKEE POST, Society of American Military Engineers, held a dinner meeting Oct. 18, at which Col. William Kelly spoke on "The Boulder Dam Project."

THE TEXAS WATER-WORKS SHORT SCHOOL will be held Jan. 14-25, 1929, at the Texas Agricultural and Mechanical College and at Bryan, Tex.

THE MISSOURI VALLEY SECTION, American Water Works Association, at its annual meeting recently held in Kansas City, elected the following: John W. Pray, Fort Dodge, Iowa, chairman; T. D. Samuel, Jr., Kansas City, vice-chairman; H. L. Brown, Salina, Kan., and H. V. Pedersen, Marshalltown, Iowa, directors. About 200 members were in attendance.

THE BALTIMORE SECTION, American Society of Civil Engineers, and the Engineers Club of Baltimore held a joint meeting Oct. 26 to hear Frank P. McKibben speak on "The Welding of Steel Buildings and Bridges." The meeting was attended by about 180.

Personal Notes

WINFRED D. GERBER, formerly engineer for the League of Wisconsin Municipalities and more recently Mayor of Glencoe, Ill., has been appointed chief engineer of the Illinois State Water Survey, with office at Urbana, Ill., succeeding George C. Habermeyer, resigned. Mr. Gerber was for several years chief engineer of the Clay Products Association.

ERNEST MCCULLOUGH and EDWARD S. HANSON, editor and managing editor of *Building Age and National Builder*, have resigned to enter private practice as consulting engineers with special attention to the promotion of publicity work in the engineering, architectural and construction field.

E. WARREN GOTWALS, formerly with the Missouri State Highway Commission, has been appointed resident engineer of construction on the $6,500,000 highway construction program of Jackson County, Missouri.

CHARLES E. LEX, JR., has been appointed city purchasing agent of Cincinnati, Ohio, the appointment to take effect Nov. 1.

J. C. BRONSON has joined the force of the Newton Baxter Company, general contractor, Toledo, Ohio, as construction engineer. Since his graduation from Ohio State University in 1924, Mr. Bronson has been field engineer and superintendent of construction for the Harrop Ceramic Construction Company, of Columbus, Ohio, building ceramic plants in Georgia, Pennsylvania, Ohio, Missouri and West Virginia.

FREDERICK E. PARSONS, formerly in the engineering department of the Erie Railroad Company, and later with Gannett, Seelye & Fleming, engineers, has resigned his position with the latter firm to accept a position with the F. E. Welsh Contracting Company, Inc., of Cleveland, Ohio, railroad contractor.

HORACE L. SEYMOUR, of Vancouver, B. C., has been appointed director of town and rural planning in the Province of Alberta under the provisions of the town planning act passed by the last legislature.

H. W. HUDSON, who until recently has been associated with Gibbs & Hill, consulting engineers, New York, on the electrification of the Virginian Railway and later on the electrification of the New York Connecting Railroad, has been appointed engineer in charge of construction of the New Jersey State Highway Commission's work in the Metropolitan District, succeeding FRED LAVIS, resigned.

CHARLES S. PINEO, recently with the Sherman Power Construction Company, is now with the Connecticut River Power Development Company at Fifteen Mile Falls, near St. Johnsbury, Vt.

Obituary

OTTO M. EIDLITZ, head of the firm of Marc Eidlitz & Son, Inc., building contractors, New York, died in that city on Oct. 30, following an illness of about a week with a stomach disorder. Mr. Eidlitz was born in New York in 1860 of Bohemian parentage. His father, Marc Eidlitz, came to New York in 1847 and later founded the business in which he was joined by his son after he graduated from Cornell University in 1881. Mr. Eidlitz became head of the firm upon the death of his father in 1892. Mr. Eidlitz had long been active in public affairs, having served the state as a member of the tenement house, employers' liability, and unemployment commissions. During the war he served as chairman of the commission on housing for industrial war workers, director of the bureau of housing and transportation and president of the U. S. Housing Corporation. From 1903 to 1905 he served as chairman of the board of the Building Trades Employers' Association. Mr. Eidlitz was a member of the American Society of Civil Engineers and the American Society for Testing Materials.

SETH PERKINS, for many years active in the construction of public works near Boston, Mass., and in Florida, died at the age of 73 in St. Augustine, Fla. Graduating from the Lawrence Scientific School, Harvard University, in 1876, Mr. Perkins immediately started work with the engineering forces constructing an addition to the water supply of the city of Boston. His connection with public-works construction in that city included the design and construction of sewers, water-works, parks and bridges; also sewer and water-works for the State of Massachusetts, and the construction of a dry dock and pier at the Boston Navy Yard for the U. S. government. During the latter years of his life Mr. Perkins became connected with the construction of the Florida Coast Line Canal and maintained an office in St. Augustine. He was a member of the American Society of Civil Engineers.

JAMES H. WATSON, 87 years old, a prominent contractor of Kokomo, Ind., died recently at his home following an illness of two weeks. He was for many years senior member of the J. H. Watson & Son Company, contractors, but a few months ago retired from business.

Construction Equipment and Materials

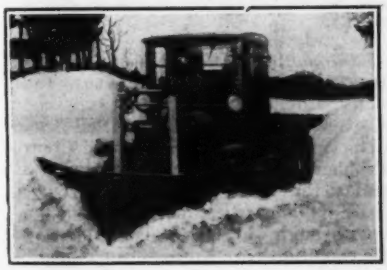
Southwest to Have Road Show

A road show and school for the benefit of the fast-growing southwestern section of the United States is to be held Feb. 26-March 1 at Wichita, Kan. The exhibits will be housed in the Wichita Coliseum, and it is expected that a complete line of machinery for road construction will be exhibited to the city officials, contractors and dealers who will attend. In connection with the road show, a good roads school will be held under the supervision of the Kansas State Highway Commission and the engineering department of the Kansas State Agricultural College, with cooperation from the U. S. Bureau of Public Roads and other interested organizations.

New Developments

Snow Plow Attachment for Trucks

Snow plows in both straight-blade and V-shaped types, either of which can be mounted on any standard 2-ton or larger motor truck, are now being manufactured by the Austin-Western Road Machinery Company, 400 North Michigan Ave., Chicago, Ill. The same type of framework is used for either blade,

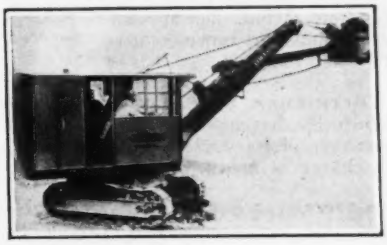


so that they may be used interchangeably. The straight-blade type has a 10-ft. moldboard made of ⅜-in. steel, flanged at top and bottom to strengthen it laterally, and provided with a removable 6-in. cutting edge or bit, which gives the blade a total height of 21 in. The blade is reinforced vertically by six 2½-in. angles, and longitudinally by a 3x½-in. angle. All rivets are countersunk to provide a smooth surface which does not interfere with the movement of the snow. This blade, when set at the usual angle of about 30 deg., cuts a path about 8 ft. wide.

The V-shaped blade cuts a path 8 ft. 4 in. in width, throwing the snow from the center to both sides. The blade is 34 in. high, including the removable cutting edge, which is made in two pieces. A replaceable steel nose casting fits over the blade and bits. The blade itself is made of ¼-in. steel.

New Model Convertible Shovel

Quick convertibility is the feature of a new shovel which can, it is claimed, be changed to crane, dragline, ditcher or skimmer in the field in less than two hours. This new model A of the Orton Crane & Shovel Company, Chicago, Ill., is built up of riveted and electrically welded plates and shapes of structural steel. Alloy steel is used for all power shafts and gears, and flexible crawling treads of the spring type distribute the

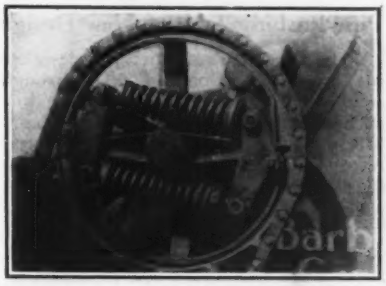


weight of the machine uniformly over the treads, even on rough ground and over obstructions. The machine can also be furnished with road wheels or for mounting on standard auto-truck chassis. The power source is a heavy-duty 53-hp. Hercules motor.

When rigged as a shovel this machine carries a ⅜-yd. bucket. The crowding device is driven by a train of gears and has a special slip-friction clutch to absorb undue shocks and jars and to prevent killing the engine. As a crane or dragline the bucket capacity is ½ cu.yd. on a 30-ft. boom.

New Overload Release Sprocket

An automatic overload release sprocket to protect bucket loaders from unusual strains has been developed by the Barber-Greene Company, Aurora, Ill., and is now being used on the machines of that company. It consists of two main elements, an outside race and a set of springs in the interior. The driving chain runs around the sprocket teeth on the outside of the race, which has two raised parts in contact with the two rollers of the spring assembly, which is keyed to the shaft. Ordinarily the pressure of the spring rollers against the raised part of the race is sufficient to make the entire sprocket turn together, thus moving the bucket line. However, when a large boulder or any other solid object tends to stop the bucket line, the springs compress, allowing the sprocket to run and the head shaft to stand still. Every half revolution thereafter causes a brief application of power to the bucket line, which intermittent action often frees the object causing the trouble and permits the machine to continue running. A tension adjustment is provided on the spring to provide for different types of material. The design of the new sprocket was adopted from that in use on the vertical boom ditcher made by the same company.



Substitute for Diamonds in Core Drill Bits

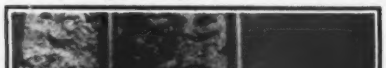
After several years of experimentation, a material which can be substituted for black diamonds in core drill bits under certain circumstances has been developed by the Sullivan Machinery Company, Chicago, Ill. The substance, which is known as "Sulamite," is a metallic alloy having practically the same characteristics as carbon or black diamonds, although not as hard. The process of manufacturing has not been made public.

The use of Sulamite in igneous rock and other hard formations is not recommended, nor it is suitable for sharp or abrasive rocks. Under these circumstances it is recognized that there is no real substitute for black diamonds, when rate of progress and cost per foot of hole are considered. However, in soft sandstone, limestone, shale or similar strata, it is claimed that the lower cost of investment for Sulamite offsets the slower rate of progress, resulting in ul-

mate economy. An additional advantage is that the loss of a bit set with Sulamite is much less costly than that of one set with diamonds. This is a real factor in formations containing seams or pockets.

Pipe-Pushing Jack of New Design

A new mechanism especially designed for pushing sections of pipe through solid earth has been added to the line of Simplex jacks by Templeton, Kenly & Company, Ltd., 1020 South Central Ave., Chicago, Ill. As shown in the illustration, this jack is seated against a wooden beam and clamps to the pipe by means of a special type of tapered circular jaw. The jaws grip the entire



circumference of the pipe, thus eliminating the tendency to kink or flatten. Operation of the two handles shown forces the pipe through the earth for a distance of 25 in., after which the jaws are disconnected by means of a sliding clamp and the guides are slid back to begin a new cycle. The jacks are made in two sizes, No. 332 for pipes of ¾ to 2 in. in diameter, and No. 354 with a capacity of 2- to 4-in. pipe. The company also supplies a special steel nose to aid the pipe in penetrating hard earth.

Business Notes

ROLLER-SMITH COMPANY, New York City, has appointed the firm of Wise & Braisted, Detroit, Mich., as its district sales agent in the State of Michigan.

ERIE MACHINE SHOPS, Erie, Pa., has appointed Staley & Morris, Philadelphia, Pa., as distributors for eastern Pennsylvania.

STANDARD POWER EQUIPMENT CORPORATION, St. Louis, Mo., has appointed M. C. Rhodes manager of its mechanical department. Mr. Rhodes was formerly in the engineering department of the Riley Stoker Corporation.

HERSEY MANUFACTURING COMPANY, South Boston, Mass., has appointed W. E. Pebworth manager of its Dallas branch.

STANDARD CONVEYOR COMPANY, North St. Paul, Minn., has appointed Robbins & Robbins as representatives in New Orleans, La.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa., has appointed R. J. McIntosh manager of its steel piling department, in charge of engineering and sales.

COPPERWELD STEEL COMPANY, Glassport, Pa., announces that Lowell S. Monroe is now a member of the Copperweld engineering staff, where he will be in charge of service data on such subjects as sag in overhead ground lines, vibration in bonding wires, resistance of earth grounds and similar engineering questions. Mr. Monroe was formerly advertising manager for the Electric Controller & Manufacturing Company.

THEW SHOVEL COMPANY has added to its organization a number of new sales and service representatives, as follows: Southern Tractor Company, Montgomery, Ala.; North Carolina Equipment Company, Raleigh, N. C.; Hall Perry Machinery Company, Butte, Mont.; Paragon Supplies, Ltd., Vancouver, B. C.; Jennison Machinery Company, San Francisco, Calif.; and R. G. Moeller Company, Detroit, Mich.

NUGENT STEEL CASTINGS COMPANY, Chicago, Ill., announces that Harold C. Osman, secretary of the company, has been appointed works manager.

New Publications

Building Insulation—NATIONAL LUMBER MANUFACTURERS ASSOCIATION, Washington, D. C., has issued an 80-page information bulletin entitled "The Cost of Comfort," which is devoted to a detailed study of heat insulation in small buildings. The booklet contains more than 36 diagrams and over 90 tables, showing in detail actual labor and material costs for various types of wall, floor and roof construction.

Rock-Crushing Equipment — GOOD ROADS MACHINERY COMPANY, INC., Kennett Square, Pa., describes rock-crushing equipment, including crushers, screens, bucket elevators, belt conveyors, chutes and gates in a new 43-page catalog. Several typical plant layouts are given, as well as complete specification tables giving sizes and capacities of the equipment.

Sludge-Bed Inclosures — BARNS ENGINEERING COMPANY, 155 East 42d Street, New York City, describes the Glass-Steel sludge bed inclosure in a 4-page leaflet. Similar in appearance to the ordinary greenhouse, these inclosures are specially designed to meet the special conditions found at sewage-works.

Automatic Drainage Gates — CALIFORNIA CORRUGATED CULVERT COMPANY, Los Angeles, Calif., has issued a 47-page illustrated book entitled "Solutions for Drainage and Flood-Control Problems." This gives various formulas for calculating runoffs, culvert sizes and capacities, head losses in flowing through gates and also a chart for the solution of Kutter's formula. It also gives information on the subject of reclamation costs, road drainage, flood control and methods of installing pipes on soft or unstable ground.

Steel Windows and Doors—TRUSCON STEEL COMPANY, Youngstown, Ohio, gives full details about its continuous steel windows and mechanical window operators for industrial buildings in a new catalog, No. 126. This 32-page booklet contains many detailed drawings of typical installations, as well as photographs of plants using the windows. A separate catalog, No. 110, gives similar information about the steel doors produced by the company, including sliding and swing-type doors for large openings, vertical folding and lift doors, and doors for fire department and airplane hangar use.

ROAD MACHINERY IN A MODERN SETTING

Modern road machinery has fallen heir to a new task, that of constructing and maintaining in proper condition the many airports which are being placed in service in all parts of the country. Construction is only a part of the job, for it has been found that the dragging tail skids of heavily loaded planes make necessary almost continuous maintenance to keep the field in safe condition, a task which modern grading machinery is well qualified to perform. This photograph, supplied by the Galion Iron Works & Manufacturing Company, shows a tractor-drawn grading outfit at work on the Lunken field airport at Cincinnati, Ohio.

The Business Side of Construction

General Business Conditions on High Level

The virtual certainty of a large and satisfactory volume of fall and winter trade adds to the prospect that 1928 will be a banner year for general business and industrial activity. Of the 38 most important lines of business and industry, thirteen are reporting current conditions as excellent, nine report conditions as good, eleven as fair and only five as poor.

The 1928 sales of farm implements will almost certainly exceed those of 1927 by from 10 to 20 per cent. Export sales of farm implements continue to show large gains and may exceed 1928 by 30 per cent. September production of automobiles was 60 per cent larger than last year, and the year's totals will probably exceed last year's by 25 per cent. It is now almost certain that new construction for 1928 will be of record proportions. With comparatively few exceptions, profits of the larger industrial chemical companies will show substantial increases for 1928 as compared with 1927, and 1928 profits in the copper industry will probably show a gain of about 50 per cent as compared with 1927. Electrical manufacturing companies in general are operating at higher rates than at this time last year, the September rate being of record proportions. The electric output and gross receipts of the public light and power companies continue their uninterrupted growth, with current operations more than 10 per cent above those of a year ago. Evidence accumulates in support of the belief that the closing six months of 1928 will constitute the best half year that the radio industry, broadly considered, has ever enjoyed. Notwithstanding the general decline in steel company earnings during the first half of the year owing to the lower average level of prices, increases should in most cases make a higher level for the year as a whole than in 1927.

That there are soft spots in the national economic structure, however, is evident from the reports of the five lines of business reporting conditions poor. With the coal industry it is doubtful if the leading companies will show better earnings than during 1927, and the majority of producers, both anthracite and bituminous, will actually report further declines. It is now a certainty that the full year's earnings of the railroad equipment manufacturers will be decidedly unsatisfactory. In the shipping business there is a large surplus of ships and keen competition depresses profits. Earnings of ship operating and building companies in general this year are not expected to be better than in 1927. The nation's traction companies are also suffering from the lack of adequate fare, competition of automobiles and general traffic congestion. It is probable that the net revenue of a great majority of the traction companies will be fully as unsatisfactory as that experienced last year.

Upward Trend in Prices

Market conditions have changed little during the last month in respect to wholesale transactions in the basic construction materials. Considerable price cutting, however, is recorded as confined to retail dealers in the principal cities throughout the country.

Of the price changes from the October level, approximately two-thirds were advances.

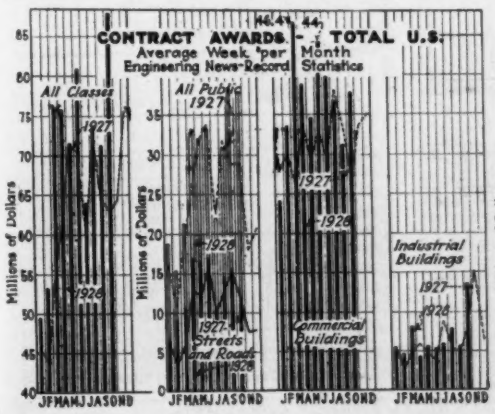
The price trend in structural shapes offers a good illustration of the present direction of the steel market. Shapes were $1.80 per 100 lb., f.o.b. Pittsburgh, in large mill lots, Jan. 1, 1928. On Feb. 1 the price went to $1.85 and remained at that level for eight consecutive months until Oct. 1, at which time the present quotation of $1.90 went into effect. The net change in ten months has been 10c. per 100 lb., or $2 per ton. The advance in steel is reflected in scrap. Heavy melting steel prices are now at highest levels that have been reached since 1926.

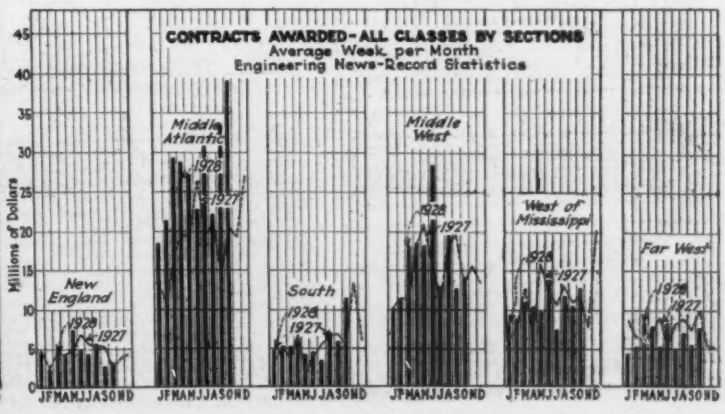
Lumber production has been systematically retarded for some time in the face of sustained demand. The result is a strong market position for lumber. Movements are heavy for this season of the year in materials for buildings, railways and industrial plants. Export trade is exceptionally heavy. Heavy shipments continue to deplete the mill stocks, with the result that wholesale prices are growing firmer in pine and fir timbers, boards, dimension stock,

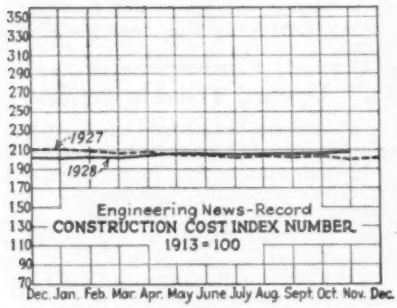
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, OCTOBER, 1928

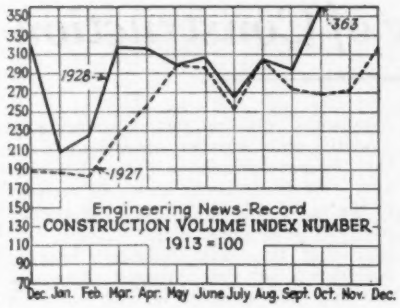
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Water-works	.....	$43,211	$139	$285	$1,319	$923	$45,877	$85,705	$65
Sewers	$297	3,654	965	1,094	1,007	244	7,261	86,389	231
Bridges	435	815	4,221	1,638	1,639	579	9,327	102,437	30
Excavations, drainage, etc.	63	133	110	902	49	274	1,531	31,584	334
Streets and roads	1,396	10,077	4,792	11,124	12,275	7,429	47,093	557,625	559
Industrial buildings	1,930	7,453	30,555	5,007	2,233	6,882	54,060	286,895	2,060
Commercial buildings	8,075	81,631	4,034	32,346	15,737	9,586	151,409	1,585,063	10,496
Federal government	98	2,107	308	624	2,013	1,194	6,344	59,834	.....
Unclassified	262	7,403	22	3,299	15,191	3,555	29,732	239,327	1,125
October, 1928	12,556	156,484	45,146	56,319	51,463	30,666	352,634	.....	14,900
September, 1928	10,955	134,554	24,792	51,501	41,250	22,159	285,211	.....	10,149
October, 1927	9,360	81,485	21,994	53,262	46,591	39,296	251,988	.....	29,795
Year to date, 1928	189,822	1,168,878	348,490	704,502	447,938	276,629	.....	3,635,459	122,653
Year to date, 1927	197,589	778,686	207,624	647,601	462,654	324,446	2,618,600	.....	118,332






1927
1928
Engineering News-Record
CONSTRUCTION COST INDEX NUMBER
1913 = 100
Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.



ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

flooring and siding. Yellow-pine flooring at principal centers of distribution is up $2.50 per 1,000 ft., while ordinary grades of Southern softwood rose $1 compared with the October level, because of scarcity due to floods. Hardwood prices are beginning to show firmness following the improvement in softwoods.

A rise of 25c. per square yard has occurred in wood paving blocks at Minnneapolis due to the advance in Southern pine.

The linseed oil price trend is upward. Northwestern flaxseed crops are now estimated to be 7,000,000 bu. under last year. It is considered too early in the season to issue a forecast for the Canadian crop outlook. The price of raw oil is now 11.4c. at Minneapolis, as against 11c. one month ago.

Asphalt prices show an unseasonal tendency to advance in some quarters. Dallas prices are up $1.50 and Pittsburgh $2 per ton.

Window glass is showing recovery from a recent downward trend, in the present reduction of two points on discounts for A and one point for B, applying on the new jobbers' list of Sept. 15, 1928, at New York warehouses.

Wholesale brick prices are gaining in firmness because of the steady reduction in yard stocks in the presence of increasing demand. Recent price changes have been confined almost entirely to dealers' transactions, in which price reductions have occurred during the last month. The principal price reduction of the month was that of $1 per thousand at New York, bringing the price to $16@$19 per thousand, delivered at site of job. With wholesale prices growing firmer, it is likely that the dealers' quotations will soon recover lost ground.

Relentless competition among dealers in expanded metal lath has rendered published prices merely nominal. A check on this movement, however, may come through hardening of the steel market. Black sheets, for instance, are up 10c. per 100 lb. at Pittsburgh mills, compared with October levels.

A considerable oversupply appears to have developed in concrete blocks, with the result that keen competition has caused reduction in prices at various cities. The decrease has amounted to not more than 2c. per block.

Construction Cost and Volume Index Numbers

Engineering News-Record Construction Cost Index Number is 209.46, compared with 207.71 on Oct. 1. It is 7.48 points higher than a year ago.

The Construction Volume Index Number establishes a record at 67 points above September and 94 points above the October, 1927, number.

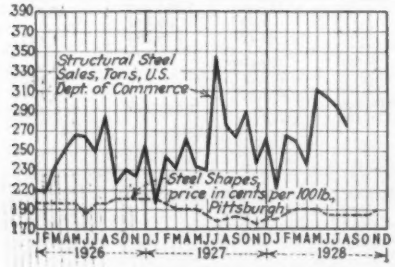
Monthly figures for 1927-28 are:

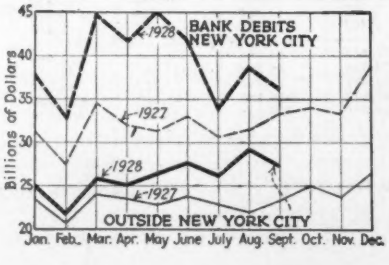
E. N.-R. Cost		E. N.-R. Volume	
Nov., 1928	**209.46**	**Oct.., 1928**	**363**
Oct., 1928	207.71	Sept., 1928	296
Nov., 1927	201.98	Oct., 1927	269
Peak June, 1920	**273.80**	**1927 (average)**	**263**
1927 (average)	**206.24**	**1926 (average)**	**228**
1913 (average)	100.00		
1927		1927	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296

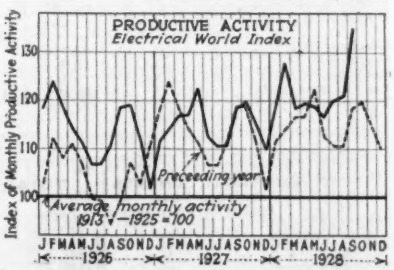
Record Construction Volume; Cost Trends Upward

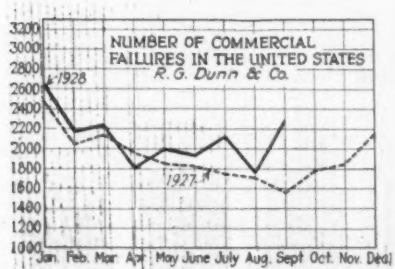
The opening of November witnessed the highest *E.N.-R.* Construction Cost Index—209.46—since February, 1927, and an index almost 4 per cent above the low point recorded in November last year. The upward cost trend which started in July appears to be headed for an even higher plane than was recorded at the opening of November, the November index being 1.75 points above October, the largest monthly gain recorded in some time.

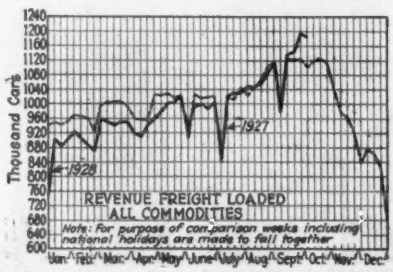
The October *E.N.-R.* Index of Volume of Contracts Awarded was far above any previous figure recorded. The index of 363 for October exceeds the former high figure recorded during last March by 45 poir's, or 14 per cent. The large October volume was due mainly to the awarding of a $42,000,000 contract by the city of New York for a water-supply tunnel.

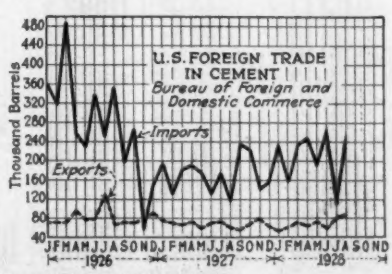

Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, price in cents per 100 lb., Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928




PRODUCTIVE ACTIVITY
Electrical World Index
Preceding year
Average monthly activity 1913 — 1925 = 100
Index of Monthly Productive Activity
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928




1927
1928
REVENUE FREIGHT LOADED ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together
Thousand Cars
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


U.S. FOREIGN TRADE IN CEMENT
Bureau of Foreign and Domestic Commerce
Imports
Exports
Thousand Barrels
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928

MOVEMENT OF MATERIALS—CHECK TRANSACTIONS—ELECTRICAL ENERGY CONSUMED

Labor Conditions Better Than Last Year

Regardless of the fact that volume of contract letting is at record level for the country as a whole, unemployment in the building trade persists in many important localities. Of ten representative cities reporting, five show conditions favorable to the building mechanics, while in the other five there are more men than jobs. At the same time, no strikes of major importance to the construction industry are in evidence anywhere throughout the United States. At this time last year plasterers were on strike in Philadelphia, Pittsburgh and Baltimore over the question of open-shop conditions.

The five cities reporting favorably are as follows:

Minneapolis—Employment continues good, with no slackening in the construction trades. A large building program is in progress, sufficient to care of the full quota of skilled or unskilled men for months to come. The situation is normal so far as other industries are concerned.

Detroit—Conditions continue normal in all trades.

Cincinnati—Building trades are operating smoothly and without labor troubles or more than the usual amount of unemployment.

Pittsburgh—Common labor has advanced from a wage schedule of 40c. to 80c. per hour to schedules paying 50c. to 80c. per hour.

Syracuse—Building is sufficiently active to enable carpenters to seek an increase of 5c. per hour from their present rate of $1.20. The five-day week is also demanded by this class.

Cities in which there is either unemployment or not enough work to justify demands for higher wages are the following:

Philadelphia—Unemployment is marked in the construction industry as well as in other industries. Marble workers who went on strike in protest against working with open-shop bricklayers have returned to work. Their demand for an advance of 12½c. per hour has been met by the employers with a proposed reduction of 25c. per hour; settlement is pending.

Cleveland—The local situation is quiet with relation to the building trades. Labor is plentiful and building permits show a tendency to decline.

Birmingham—A building program of ample proportions is furnishing employment for local building trades mechanics. An oversupply, however, exists in all of the building trades owing to the arrival of migratory laborers from other parts of the country.

St. Louis—There is considerable unemployment in the St. Louis district, especially among unskilled workers. Depression is particularly noticeable in iron-working and steel plants, automobile factories, planing mills, boot and shoe factories, instrument works, furniture factories and food industries. In building construction there has been a noticeable slackening of new projects since July. Fewer building trades mechanics are employed today than 30 days ago. Despite the surplus of workers, the union organizations have maintained the existing level of wages for the principal crafts and have also succeeded in obtaining an increase of 12½c. per hour for steamfitters.

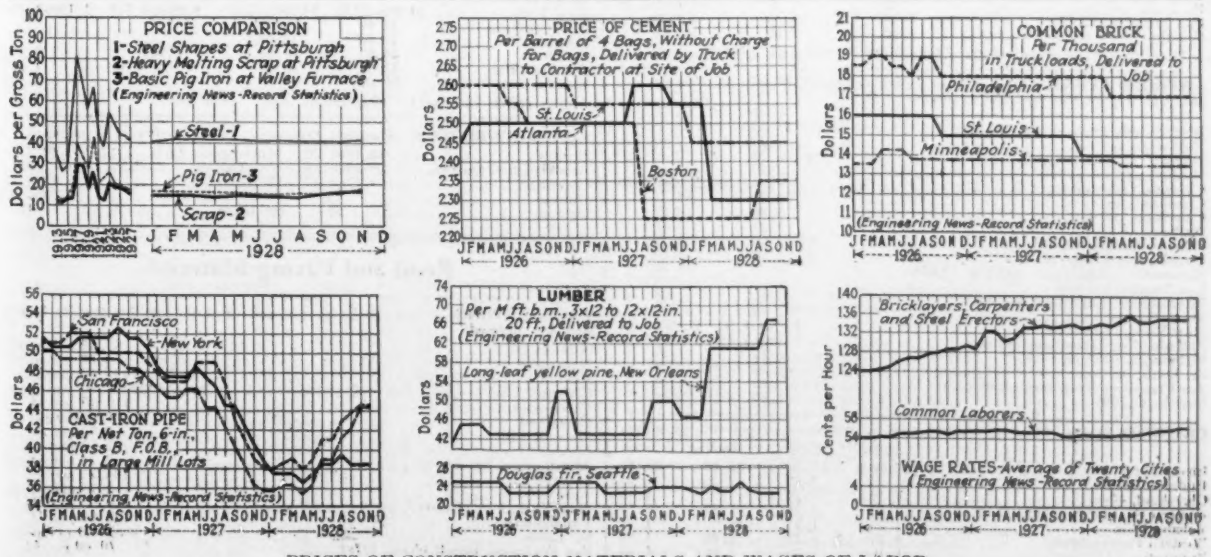
New York City—The demands of the building trades for a five-day week and 10 per cent wage increase, made a month ago, have been postponed indefinitely.

The brightest spot in the building trades on the North American continent is Toronto, Canada. Building trades in Toronto are enjoying the most active period of employment in fifteen years. This is particularly true of plasterers, carpenters and bricklayers.

The average skilled building trades rate for the country is $1.35⅓ per hour, unchanged from the October level. In November, 1927, the rate was $1.34 per hour. Common laborers receive an average rate of 56.53c. per hour, compared with 56.28c. in October and 54.50c. per hour in November, 1927.

CURRENT BUILDING TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.75	.25@.40
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.50	1.37½	1.37½	.92½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.50	1.00@1.50	.90@.96½	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.67½	1.12½	1.25	.40@.75	1.25	1.25	.35@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.35@.75
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.45@.60
Montreal	1.12	.75	.75	.40	.50	1.00	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.75
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.50@.80
St. Louis	1.75	1.50	1.50@1.65	1.00@1.15	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70



PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

Current Prices of Construction Materials

Price advances since last month are in icated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl. delivered to contractors, in carloads, *without charge for bags*. Cash discount not deducted.

	Nov. 1, 1928	One Month Ago	One Year Ago
Atlanta	$2.30	$2.30	$2.45
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Boston	2.35	2.35	2.05f.o.b.
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.05
Cincinnati (f. o. b.)	2.22	2.22	2.32
Cleveland (f. o. b.)	2.24	2.24	2.24
Dallas	2.15	2.15	2.05f.o.b
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55f.o.b.	2.55f.o.b.	2.85
Detroit (f. o. b.)	1.95	1.95	2.00
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	2.19	2.19	2.19
Jersey City	2.35	2.35	2.13f.o.b.
Kansas City, Mo.	*2.17*	2.20	2.07f.o.b.
Los Angeles	2.66	2.66	2.56
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.41	1.41	1.41
New Orleans	2.40	2.40	2.32
New York	2.25@2.35	2.25@2.35	2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	2.41	2.41	2.40
Pittsburgh (f. o. b.)	2.04	2.04	2.04
St. Louis	2.45	2.45	2.05f.o.b.
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.51
Seattle	2.70	2.70	2.65
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Leeds, Ala.	$1.65
Buffington, Ind.	1.80	Lehigh Valley District	1.75
Clinchfield, Ga.	1.65	Mason City, Ia.	1.80
Fordwick, Va.	2.05	Mitchell, Ind.	1.90
Hannibal, Mo.	1.90	North Birmingham, Ala.	1.45
Hudson, N. Y.	1.75	Richard City, Tenn.	1.85
Iola, Kan.	1.85	Steelton, Minn.	1.85
Kingsport, Tenn.	2.05	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Prices are per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	$3.50	$3.50	$2.50
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600)	3.00	3.00	2.65
Boston, per ton	1.90	1.90	1.35
Chicago	2.05@2.20	2.05@2.20	2.05@2.20
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	2.70	2.70	2.50
Dallas	2.50	2.50	2.25@3.00
Denver (2,700)	1.80	1.80	1.30
Detroit (2,600)	3.25	3.25	2.75
Kansas City, Mo.	2.40	2.40	...
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800)	2.25 ton	2.25 ton	1.00
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700) (2,500)	3.00	3.00	2.00
New York	3.25@3.50	3.25@3.50	2.00@2.25
Philadelphia, per ton	2.05@2.90	2.05@2.90	1.40@2.25
Pittsburgh, per ton, f.o.b.	...	...	1.25
St. Louis, per ton	1.90	1.90	1.60@1.90
San Francisco (2,800)	1.80	1.80	1.40
Seattle (3,200) (2,850)	2.00	2.00	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are per cu.yd. delivered. Weight 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.25	$3.25
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	2.50	2.50
Boston, per ton	2.25	2.25
Chicago, Limestone	2.05@2.20	2.05@2.20
Cincinnati, per ton	2.25	2.25
Cleveland, per ton	3.00	3.00
Dallas	3.25	3.40
Denver, Granite (2,700)	2.50	2.50
Detroit, Limestone, per ton	2.50	2.60
Kansas City, Limestone, per ton, (2,450)	*2.00*	*2.00*
Los Angeles, per ton	2.15	2.15
Minneapolis, Limestone, per ton	2.25	2.25
Montreal, per ton	2.10	2.10
New York, Limestone	3.25@3.50	3.25@3.50
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton, f.o.b.	2.75	2.75
St. Louis, per ton	2.20	2.20
San Francisco, Trap rock (2,400)	1.70	1.70
Seattle, (2,700)	1.90	1.90

CRUSHED SLAG—Price of crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.25	$2.05	$0.80
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.20	1.20	...	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	...	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Price of hollow building tile per block delivered to contractor in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.072	$0.136	$0.163	$0.181	$0.2232
Baltimore	.095	...	.175	...	.232
Birmingham	.09	.127	.174	...	...
Boston	.08	.1025	.14	$0.1775	.24
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	...	.136	...	.205
Cleveland	.064	.088	.128	.172	.19
Dallas	.096	**.1205**	**.1785**	...	.284
Denver	.0975	.135	.175	.2125	.25
Detroit	.092	.127	.208	.256	.293
Kansas City	.0535	...	.158	...	.242
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0842	...	.1476	...	.2441
Montreal	.12	...	.22	...	.315
New Orleans	.09	.125	.165	.22	.245
New York	.0973	.1459	.1824	...	...
Perth Amboy, N. J. (f.o.b.)	...	...	...	.252	.312
Philadelphia	.11	.145	.22	.27	.34
Pittsburgh	.068	...	.1175	...	.1726
St. Louis	.078	.105	.145	.175	.210
San Francisco	.108	.156	.255	...	...
Seattle	.10	...	.18	...	.26

BRICK—Contractors price, delivered, per M, is as follows:

	Common	Paving 3x8¼x4-in.	Paving 3¼x8¼x4-in
Atlanta	**$14.75**	$38.00*	$45.00†
Baltimore	15.00	40.00	45.00
Birmingham	15.00	32.00*	36.00†
Boston	17.25	45.00	50.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	14.50	35.00	.....
Denver, salmon	12.00	...	...
Detroit	15.50	35.50	38.50
Kansas City	14.00	.....	.....
Los Angeles	11.00	.....	.....
Minneapolis	13.50	.....	.....
Montreal	20.33	...	...
New Orleans	16.00	40.00*	50.00
New York	*16@19*	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	...	...
St. Louis, salmon	14.00	37.50	40.00
San Francisco	13.00	...	...
Seattle	*14.00*	50.00	55.00

*2¼x8¼x4 in. †3x8¼x4.

LIME—Prices delivered to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$27.50	$15.00	$2.30†	$2.10†
Baltimore	20.00	14.00	2.55†	.....
Birmingham	22.00	16.00	2.40†	1.85†
Boston	20.00	14.25	3.85*	3.00*
Chicago	20.00	18.00	.....	1.50†
Cincinnati	16.80	13.20	.....	13.20‡
Cleveland	20.00	16.00	2.50	2.50
Dallas	20.00	.....	.....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	**28.00**	**24.00**	**3.00†**	**2.75†**
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	21.00	21.00	.....	15.00‡
New Orleans	.....	.....	.....	2.80*
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	20.00	18.00	...	...
St. Louis	24.00	18.00	2.50†	2.10†
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	24.00	.....	.....	2.80*

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	*.18*
Brooklyn and Queens	.15@.17	New Orleans	.22
Cleveland	.17@.18	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20@.22
Detroit	.15	St. Louis	.18

Road and Paving Materials

PAVING STONE—Prices, f.o.b., in carloads or cargo lots for granite blocks 4x8x4-in. dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd.
Minneapolis, Sandstone	2.74 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.75 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd	150.00 per M.
Philadelphia	125.00 per M.
St. Louis	3.30@3.40 per sq.yd.
San Francisco, Basalt block, 4x7x8	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices f.o.b. in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	18	2.40
Chicago	3½	16	2.10
Dallas	4	18	3.90
Kansas City	3½	16	3.85
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.30
New York	3½	16	2.70
St. Louis	3½	16	2.30

FLAGGING—Prices in fair-sized quantities, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.; Cross-walk, 6x24-in., $1.30 per lin.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St Louis*: Class "B" straight, delivered, 5x16 in., 80c. per lin. ft.; roundings, $1.15 per lin.ft.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$22.60	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	21.00
Boston (Mexican)	24.50	18.25
Chicago (Texas)	24.50	21.30
Cincinnati (Kentucky Rock)	.....	11.65
Dallas (Texas)	26.00	.....
Denver (California)	35.00	.....
Detroit (Mexican)	24.00	19.00
Kansas City, Mo. (Texas)	*19.50**	*24.50*
Los Angeles ("D" Grade, California, f.o.b. El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	23.00	.....
Minneapolis, (Stanolind, f.o.b. Twin Cities)	29.10	20.10
Montreal (Imperial)	28.00	21.50
New Orleans (Mexican)	20.00	17.00
New York (Texas)	24.50	16.50
Philadelphia (Mexican)	20.00	18.00
Pittsburgh	30@32	28@22
St. Louis (Mexican)	23.50	19.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b Richmond refinery)	19.50	13.50

*At refinery.

ROAD OILS—Price, f.o.b. in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0475
Dallas, 40@50% asphalt	.06
Dallas, 50@60% asphalt	.06
New York, 40@50% asphalt (at terminal)	.06
New York, 50@60% asphalt (at terminal)	.06
St. Louis, 40@50% asphalt	.0385
St. Louis, 50@60% asphalt	.0385

Iron and Steel

PIG IRON—Per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 2.25@2.75	$16.25
Pittsburgh, basic, incl. freight ($1.76) from Valley	19.26

STRUCTURAL STEEL—Per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	*3.60*	3.75
New York, warehouse, delivered, 250 to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b.	1.90*	1.90*
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

*As of Oct. 25, 1928.

BARS, CONCRETE REINFORCING—Per 100 lb. for ¼-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	2.25@3.00
Dallas, warehouse, delivered	3.50
New York, warehouse, delivered, 250 to 3,999 lb.	2.80@3.25
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$15.00	$19.00	$14.00	$18.50	$21.50	$18.50
2.5	16.00	20.00	15.00	19.50	24.00	19.50
3.0	17.50	22.50	16.50	21.00	.....	22.00
3.4	20.00	24.50	18.00	22.50	30.00	24.00

WIRE REINFORCEMENT FOR CONCRETE—Price per 100 sq.ft.in carloads at mills; from warehouses in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	.....
180	78	3.35	3.43	4.73	3.60	3.47	.....

STEEL SHEETS—Per 100 lb.:

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$3.80	$4.65
Cleveland, warehouse, delivered	3.25	3.50	4.35
New York, warehouse, delivered	3.90*	4.20	4.95
Pittsburgh, large mill lots, f.o.b.	2.00	2.65@2.75	*3.50@3.60*
St. Louis, warehouse, delivered	3.45	4.10	4.95
San Francisco, warehouse, delivered	4.00	*4.50*	5.40

*250 to 3,999 lb.

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Per 100 lb., full packages:

	Round-head Structural, ½-In.	Cone-head Boiler, ½-In.
Chicago, warehouse, delivered	$3.60	$3.90
Dallas, warehouse, delivered	5.00	5.30
New York, warehouse, delivered	5.00	5.30
Pittsburgh, large mill lots, f.o.b.	2.90	3.20
St. Louis, warehouse, delivered	3.75	4.05
San Francisco, warehouse, delivered	5.75	6.05
Seattle, warehouse, delivered	4.50	.....

STEEL SHEETPILING—The base price f.o.b. Pittsburgh for large mill lots is $2.25 per 100 lb.

SHIP SPIKES—Per 100 lb., black, from warehouse stocks; galvanized about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$6.55	$6.10	$5.75
Seattle	7.75	5.65	5.50

Pittsburgh base in lots of 200 kegs or more, $3.00 per 100 lb.

NAILS—The following quotations are per 100 lb. keg delivered from warehouse stocks, also Pittsburgh mill base:

	Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
Wire	$2.55	$3.10	$3.10	$2.83	$3.75	$3.60	$4.95
Cut	2.80	3.30	....	....	5.00	5.00	5.00

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$11.75@$12.25	$14.00@$14.50	.....
Stove plate	*8.75@9.00*	14.00@14.50	.....
No. 1 machinery cast	15.00@16.00	16.50@17.00	$13.00@$13.50
Machine shop turnings	8.00@8.50	7.25@7.75	8.50@8.75
Cast borings	6.50@7.50	11.00@11.50	9.00
Railroad malleable	10.00@10.50	15.25@15.75	.....
Re-rolling rails	11.50@12.00	16.50@17.00	12.00@13.00
Re-laying rails, 56@60 lb.	23.00@24.00	23.00@25.00	.....
Heavy melting steel, No. 1	12.00@12.50	14.00@14.50	12.50@12.75
Iron and steel pipe	10.75	.....	8.25

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00
Light rails, 25 to 45 lb.	36.00	34@36	36@38
Re-rolled rails	30@32	34@36	.....

RAILWAY TIES—For fair-sized orders, f. o. b., the following prices per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.10	1.70
	Red oak, creosoted	1.45	2.40
San Francisco	Sap pine or cypress, untreated	.80	1.30
	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75	1.25
	Birch or maple, creosoted	1.25	1.55

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Per 100 lb. f.o.b. Pittsburgh mill for large mill lots together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, $\frac{5}{16}$-in. and larger	$2.80	$3.55	$3.00	$3.65	$3.85
Track bolts	3.80	4.55	3.90	4.65	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.00	4.00	4.25
Tie plates	2.15	2.15*	.....	....	.....

*At Chicago mills in carloads.

Pipe

WROUGHT-STEEL PIPE—Discounts from standard list:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Price per net ton for bell and spigot pipe, Class B and heavier, f.o.b., in large mill lots:

	4-In.	6-In. and Over
Birmingham mill	$39.00	$36.00
Burlington (N. J.) mill	39.00	36.00
Chicago	47.20@48.20	44.20@45.20
New York	41.60	38.60
Pittsburgh	47.50	44.50
St. Louis	44.60	41.60
San Francisco	49.00	46.00

Gas pipe and Class A $3.00 per ton extra.

SEWER PIPE—Prices are delivered in cents per foot for standard pipe; 6, 8 and 12-in. single strength and 18, 24, 30 and 36-in. double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	....	$1.70	.....	.....
Baltimore	.16	.24	.46	.....	1.53	.....	$6.50
Birmingham	.135	.2215	.4015	$1.4685	2.665	$3.90	5.06
Boston	.17	.27	.51	1.20	1.85	3.00	5.50
Chicago	.16	.28	.54	1.25	2.25	.....	.....
Cincinnati	.135	.21	.405	.75	1.35	2.16	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	8.18
Dallas	.256	.42	.794	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	.....	.....
Kansas City	.21	.29	.52	....	1.90	3.80	.....
Los Angeles	.21	.27	.486	.....	1.74	.....	.....
Minneapolis	.1575	.25	.45	.85	1.80	3.75	4.94
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.195	.325	.5525	1.105	2.112	.....	.....
New York	.20	.32	.61	1.50	2.70	5.12	7.91
Philadelphia	.117	.182	.351	1.025	1.845	3.60	5.6375
Pittsburgh (f.o.b.)	.0945	.147	.2835	.90	1.62	3.024	4.8175
St. Louis	.1645	.26	.468	.78	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.32	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Prices are delivered per 1,000 lin.ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Francisco	Seattle
3	$45.00	$45.00	$50.00	.....	.....	$40.00
4	56.00	56.00	50.00	$73.00	$67.50	60.00
5	.....	80.00	85.00	110.00	86.25	.....
6	90.00	105.00	85.00	118.00	112.50	90.00
8	150.00	175.00	195.00	150.00	175.00	.....

Miscellaneous

LINSEED OIL—Raw oil, f.o.b. in 1- to 4-bbl. lots, per lb.:
New York....$0.109 Chicago....$0.109 Minneapolis....$0.114

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.25; Red, dry, $13.25; Red, in oil, $14.75.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.30@ 5.50
Soda ash, 58%, in bags, per 100 lb	1.32@ 1.35
Chlorine, liquid, cylinders, per lb	.05½@ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb	2.00@ 2.10

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 8-ft.; ⅜-in., 6-ft.; ½-in., 4½-ft.; ⅝-in., 3½-ft.; ¾-in., 2-ft., 10-in.; 1 in., 2-ft. 4 in. Following are prices per pound for ¼-in. and larger delivered in 1,200-ft. coils:

Atlanta	$0.25	Kansas City	$0.26
Baltimore	.22½	Los Angeles	.25
Birmingham	35@.40	Minneapolis	.22
Boston	.25	Montreal	.24½
Chicago	.20	New Orleans	.23¾
Cincinnati	.21	New York	.24
Cleveland	.21	Philadelphia	.24
Dallas	.20	San Francisco	.20½
Denver	.23	Seattle	.20½
Detroit	.24½	St. Louis	.19½

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carloads:

Asphalt felt, per 100 lb	3.50
Tar felt, per 100 lb	$3.27½
Asphalt coating, per gal	.40
Tar pitch, in 350 lb. barrels, per ton	31.00

PREPARED ROOFINGS—Prices to contractors, in carloads, f.o.b., New York per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses.
AA .....83% A .....86% B.....88%

EXPLOSIVES—Prices per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1967	.2173
Birmingham, f.o.b.	.155	.185	Montreal	.195	.22
Boston	.245	.27	New Orleans	.235	.26
Chicago	.195*	.22*	New York	.26‡	.2825‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.24	.29	St. Louis	.215	.24
Denver, f.o.b.	.1925	.215	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Prices of rough Douglas fir, No. 1 common, at yards; prices delivered to contractor at site of job, $1.50 to $5 per M. ft. additional:

	10-16-18 and 20 Ft. No. 1 Douglas Fir	22 and 24 Ft. No. 1 Douglas Fir
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Prices, f.o.b., in carloads, per M. ft. b.m.; prices delivered to job in truckloads from stock, $10 per M. ft. additional:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$37.50	$42.00
3x10 to 10x10	46.50	42.00
3x12 to 12x12	56.50	42.00
3x14 to 14x14	.....	43.00

New York—Prices per M. ft., b.m., wholesale, for rough, long-leaf, yellow-pine timbers in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$41.00@$43.00	$42.00@$44.00
3x10 to 10x10	48.00@ 50.00	49.00@ 51.00
3x12 to 12x12	55.00@ 57.00	56.00@ 58.00
3x14 to 14x14	63.00@ 65.00	64.00@ 66.00

Other Cities—Prices delivered per M.ft., b.m.:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$45.00	.....	.....	.....	$65.00	.....
Baltimore	36.00	$50.25	$54.00	$61.50	75.00	$50.50
Birmingham	35.00	.....	.....	.....	40.00	.....
Boston	48.00	47.00	47.25	50.00	56.00	50.00
Cincinnati	36.00	49.00	47.00	47.00	40.00	53.00
Dallas	57.50	57.50	.....	.....	57.50	57.50
Denver	.....	32.25	.....	.....	57.00	33.25
Detroit	65.00	55.00	.....	.....	65.00	55.00
Kansas City, Mo.	42.50	41.75	.....	.....	55.50	42.75
Los Angeles	.....	44.00	.....	.....	.....	44.00
Minneapolis	54.00	49.25	36.25‡	.....	54@56	49.25@50.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	.....	.....	.....	67.00	.....
Philadelphia	52.00	35.00	42.00	40.00	65.00	35.00
St. Louis	45.00	39.00	.....	.....	53.50	39.50
Seattle	.....	23.00	.....	.....	.....	22.50

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$47.50	.....
Baltimore	56.00	$45.00	$45.00	35.00	$48.00
Birmingham	36.00	.....	.....	48.00	.....
Boston	44.00	42.75	43.50	48.50	47.50
Cincinnati	30.00	35.00	33.00	31.00	48.00
Dallas	.....	.....	.....	57.50	.....
Denver	.....	45.00	31.25	.....	45.00
Detroit	42.00	.....	.....	40.00	.....
Kansas City, Mo.	51.50	41.75	.....	44.25	36.25
Los Angeles	.....	38.00	.....	.....	57.00
Minneapolis	49.00	43.00	38.75‡	49.00	44.00
Montreal	45.00	48.00	40.00	85.00	70.00
New Orleans	48.00	.....	.....	50.00	50.00
Philadelphia	55.00	36.50	36.00	52.00	36.50
St. Louis	39.00	.....	.....	29.50	.....
Seattle	.....	22.00	.....	.....	23.00

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41